the tech engineering news

january 1950

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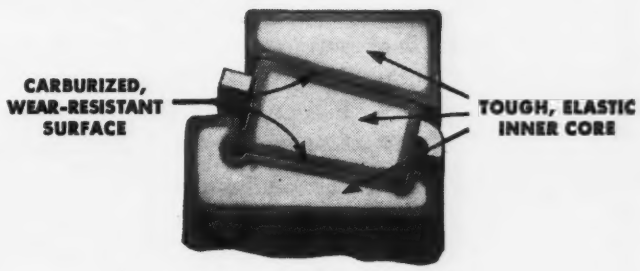

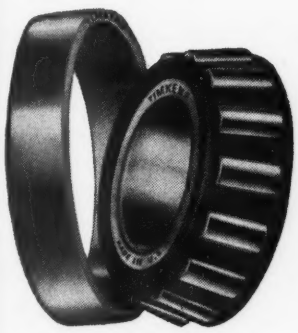

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tech engineering news

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spectroscopy at m. i. t.

The Tools of a Basic Science Are Found Here

By John Mathis, '53, and Sherwin Kalt, '53

Few of us at Tech realize that the small, windowless extension jutting from behind Building 6 into the inner courtyard houses one of the best equipped, most famous spectroscopy laboratories in the world. Within it one can find many complicated instruments which are vastly important tools in man's search for the inner secrets of molecular structure.

But what is spectroscopy, and why is it so important? Spectroscopy is in its broadest sense the study of light. A scientist can, by measuring the intensity and wave length of the light emitted or absorbed by a substance, draw conclusions regarding its composition and structure. In order to do this, the scientist must find means of producing radiations, measuring them, and interpreting their significance.

In the case of either absorption or emission of energy by a substance, the radiation produced must be broken up into a spectrum similar to that formed when visible light is passed through a prism. Some types of radiant energy besides light can be broken up by a prism; however, in actual practice the spectroscopist often relies on a more versatile tool, the diffraction grating.

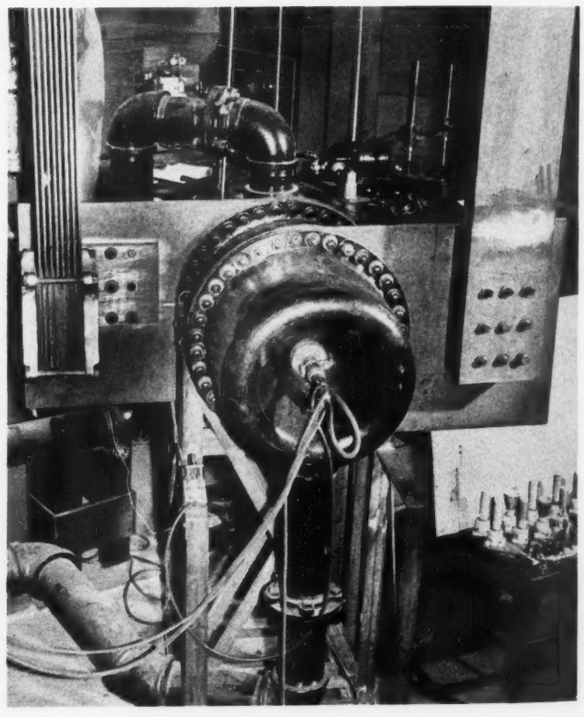
The grating is a device which can break a wide range of radiation into bands of monochromatic light by means of a series of parallel lines ruled on either a transparent or a reflecting surface. This grating is widely used because of its great resolving power, or ability to disperse light. It is one of the basic devices in use in modern spectroscopic labs.

The spectroscopy laboratory at M. I. T. is especially well fitted to extend man's knowledge of spectral radiations. It has the distinction of occupying the only building in the world designed specifically for spectroscopic investigation. The construction of the building gives the lab some advantages over other spectroscopic laboratories.

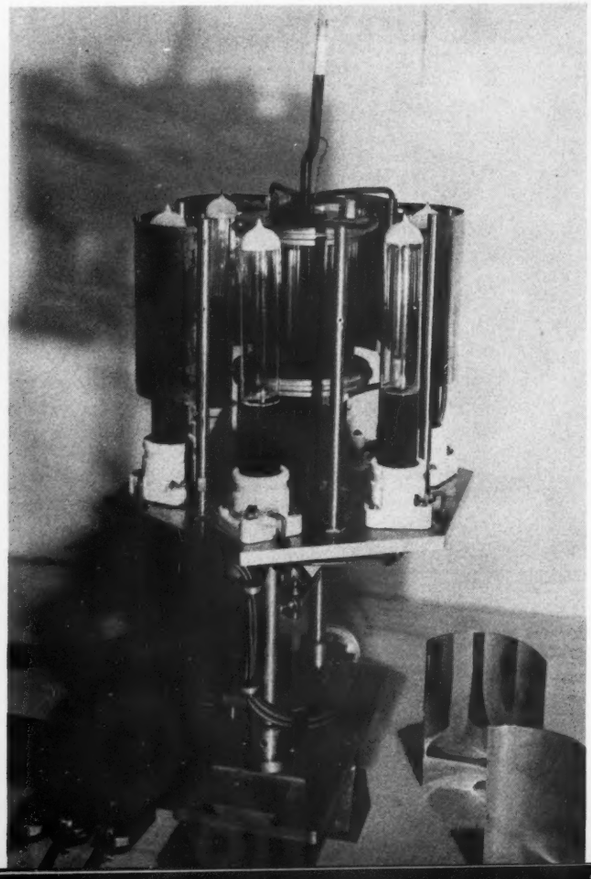
A casual visitor's curiosity is immediately aroused by the three heavy doors guarding the entrance to the lab. These doors, as well as the thick walls consisting of layers of concrete, cork, and felt, are designed to maintain a constant temperature within the building. So efficient is the insulation that the air conditioning system has to remove only the heat liberated within the lab by the workers, lights, and instruments.

The dim lighting and cool, still air of the main room give it a cavelike atmosphere which is somewhat relieved by the array of equipment lined along both walls. Several doors on each side lead to smaller workrooms where the actual spectroscopic work is done.

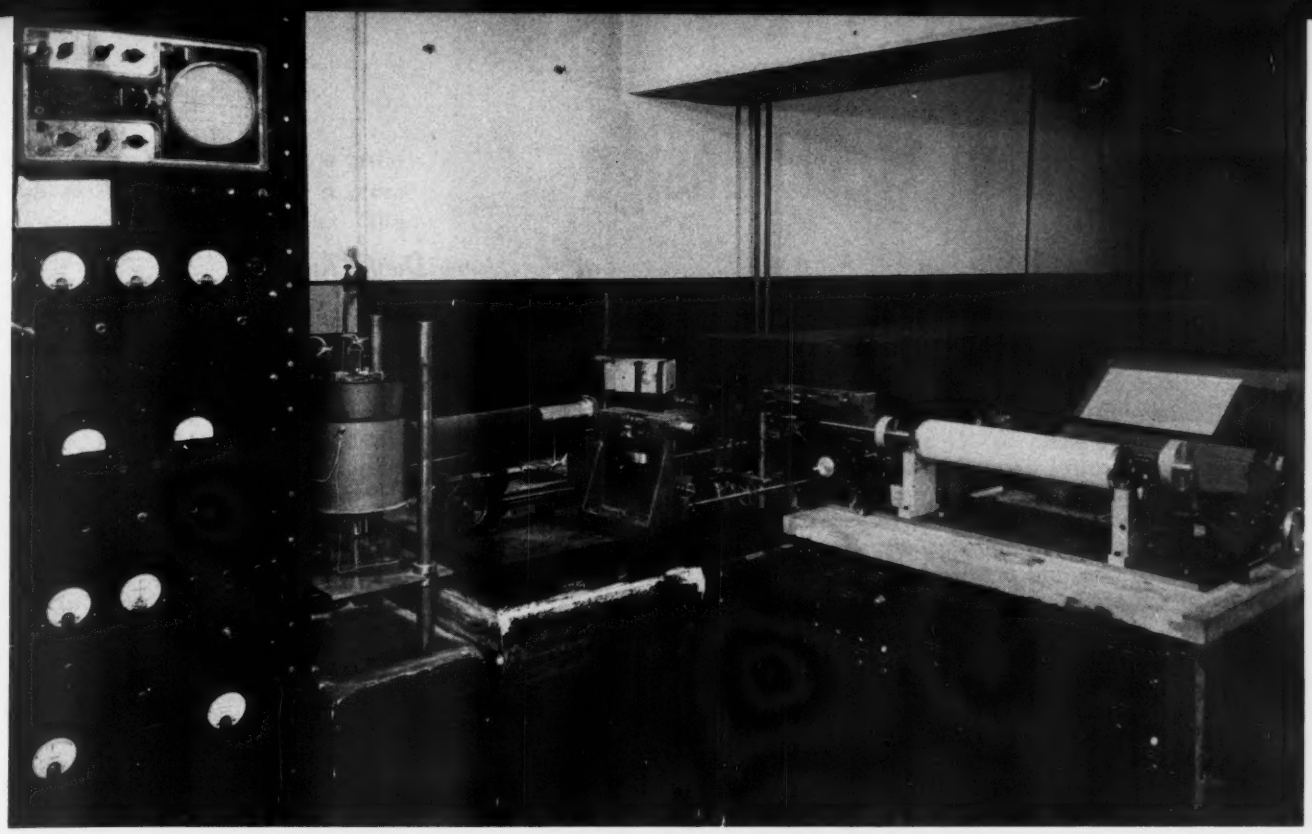
One of these rooms has a floor built on a foundation separate from the remainder of the Institute. It is con-



The copper bus bars at the left carry the huge currents required by this Bitter magnet. The cooling pipes visible help dissipate the heat generated.



This gadget is a "light furnace" which bombards targets with intense light radiation.



The spectrophotometer is used for producing and measuring wave lengths in the ultra-violet range.

nected to the rest of the building only by a flexible material which will not transmit vibrations. In this room is mounted a Paschen spectrometer, which consists of a semicircular track of diameter twenty-one feet, with a light source at one end; a diffraction grating, which breaks up the light into its spectrum, at the other end; and photographic plates arranged along the track to record the images. This spectrometer is capable of attaining such accuracy that the slightest vibration, or variation in temperature, may significantly change the result. For this reason thermostatic controls keep the temperature within a range of 0.1° F.; a person's body heat will set off these controls within a few minutes. The Paschen spectrometer, because of its large semicircle of photographic plates, has the distinct advantage of being able to record a wide range of the spectrum at one setting.

Within the same room we also find the Wadsworth spectrometer, which consists of an I-beam twenty-one feet long, pivoted on one end and supported at the other by a similar fixed beam. The angle formed by the two beams can be made to vary slightly from the right angle. By means of a concave mirror, light from a source is reflected on a diffraction grating, broken up into its spectrum, and photographed on a single plate. This spectrometer can record only a limited portion of the spectrum, but the exposure time for each film is less than that of the Paschen because the image of each spectral band is narrower and hence more concentrated.

At present this instrument is being used to investigate the molecular structure of various gases by recording the wave lengths of the radiation they absorb. The gas to be studied is placed within a quartz tube approximately nine feet in length surrounded by a heater, and a powerful beam of arc light is projected through the tube. The pressure of the gas may be varied from one millimeter to two atmospheres, and its temperature from 20° C. to about 500° C. Since the radiation is absorbed because of the vibration of the atoms within their molecules, the arrangement of these atoms may be inferred from their absorption spectra.

Another phase of the laboratory's activity is the investigation of atomic structure by means of the effect of an electromagnetic field on an element's spectrum. The magnetic field is produced by a thick coil of 200 turns of copper ribbon surrounding a hollow core. Through the coil flows a current of 10,000 amperes at 170 volts. While the magnet is in operation, 800 gallons of water per minute are pumped around the coil in order to remove some of the heat produced. So great is the magnet's power consumption that it can be used only on days when the load on the Cambridge generator is small and when the wind tunnel is not in operation.

The substance to be studied is vaporized within the core of the magnet by means of an electric arc. The light emitted passes through a tube into a room. There a second semicircular Paschen spectrometer, with a diameter of ten meters, is used to photograph the material's spectrum. This spectrum differs from the ordinary type in that some lines which were originally single are split into several adjacent bands due to the effect of the magnetic field on the element's electrons. The atomic structure may be inferred from a study of the spectrum produced.

The laboratory is also engaged in work on a large ruling engine for producing diffraction gratings. This machine, developed by Professor A. A. Michelson at the University of Chicago, was capable of producing the world's finest gratings before the year 1920. However, since then it has been in the process of rebuilding and improvement. Recently the University of Chicago gave it to M. I. T. on the condition that it be completed and put into operation. Work is being done on the machine and within a year it is expected to be producing gratings of higher resolving power than are now available.

A unique and invaluable device developed, built, and perfected at the Institute is the automatic com-

(*Continued on page 22*)

a new era in truck design

Many Considerations Enter the Design of Cabs for Heavy Duty Trucks

By Charles M. Jordan, '49

The following article is an abstract of part of Charlie Jordan's Bachelor's thesis on "Heavy Duty Mack Truck Styling." The pictures associated with the article were also taken from the thesis, which, although extremely interesting, is too long to be reproduced in full. Many thanks are given to both the author and Professor John E. Arnold for their co-operation and permission in the printing of this article. — ED.

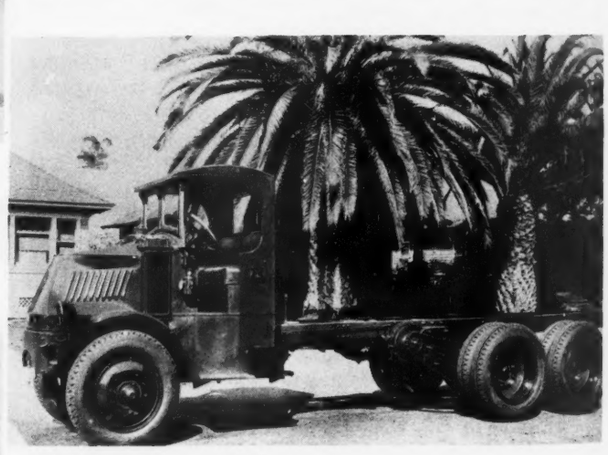
The styling of trucks until recent years (what little styling was used) was done on the basis of sharp lines and definite mass relationships, yielding a very square angular design. Since the war, however, a new trend has appeared in light duty truck styling — a trend which closely parallels automobile styling in that emphasis is placed on form rather than line. This trend features sweeping, bulging surfaces and takes advantage of the fact that the public has been well educated in curves with respect to streamlining. Such "streamline styling" is well suited to light trucks which are in some cases no more than rugged, overgrown automobiles.

We are concerned here, however, with the styling of heavy duty trucks — trucks which are big, powerful, precision-engineered workhorses built to do heavy work with ease for years. Such is an entirely different function from that of light trucks.

To be honest, therefore, we must develop a theory of styling which will be consistent with the construction and task of heavy trucks. Such trucks were never meant to be beautiful or to be a suave, sleek gob of sheet metal. Heavy trucks must be purely functional and should be styled as such. We should not be ashamed of the power built into these units or want to cover up their precise engineering with vast areas of bulging sheet metal. We should adopt a "functional styling" of crisp, sharp lines contrasted with functional form which will accentuate the mass, power, and ruggedness typical of these vehicles.

The illustrations show Mack Trucks of past years and the present Mack production model LJ. With the LJ is a corresponding new design developed in the spirit of "functional styling," a design which conceivably could be put into production within the next several years without making too radical a change. Along with the new design is a drawing showing the same truck redesigned in the "streamline" vein. Other designs shown are more radical departures from present practice representing possible future styling in both the "functional" and "streamline" philosophy.

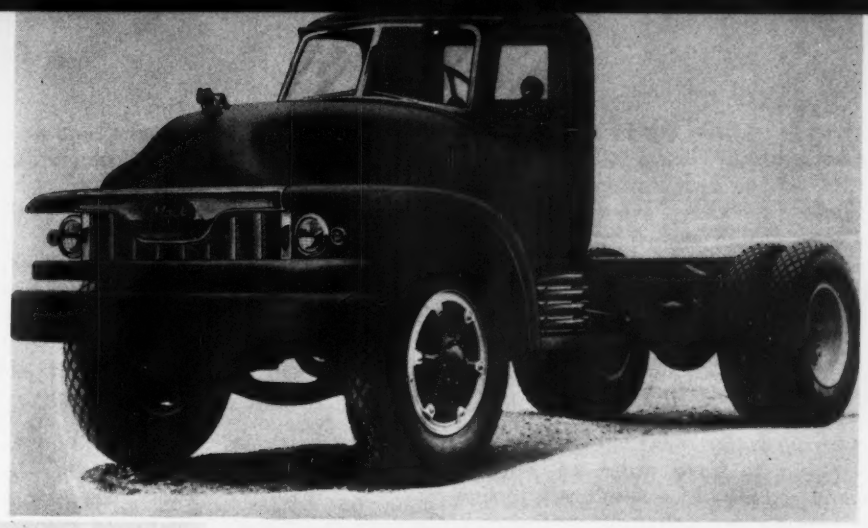
With the concept of functional styling behind us, let us now consider some of the factors which the truck stylist must take into account in the design of the new model.



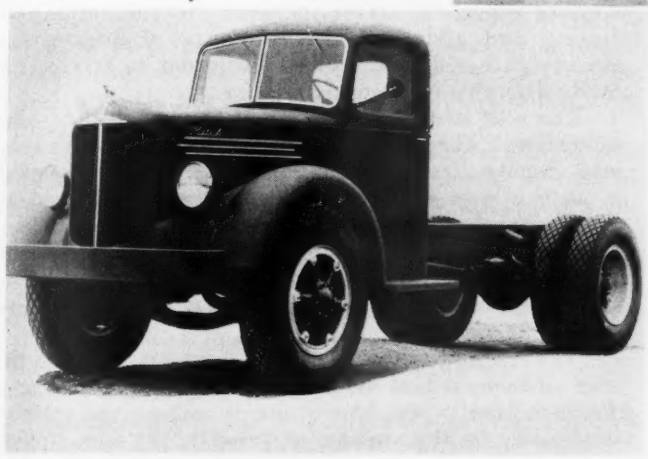
Three of Mack's famous old models: Above, the first Mack production model, Type 2, produced from 1902 to 1912; right, a well-known "Bulldog" Mack, the 1935 Model AC; below, the more recent Model EQ, made in 1937.

The approach to truck cab and sheet metal design requirements must be considered from at least four basic viewpoints, all of which often differ rather widely from one another: the owner, the maintenance mechanic, the driver, and the truck manufacturer.

The owner or operator is naturally interested in earning the greatest possible return from his invest-



The present Model LJ with a redesign of the same truck in a more "functional" type of styling. The styling here shown was kept conservative with the idea that such a design could conceivably be produced in a few years without making too sharp a break with present trends.



ment. As a result he expects his vehicles to haul the greatest possible load in the shortest possible time through twenty-four hours. With strict legal limits imposed on lengths and widths, it is the tendency to shorten the cab as much as possible to allow for a greater payload. Since even greater power seems to be desired in order to move the payload at a faster rate, the trend toward larger engines tends to steal more length from the cab. The owner insists that the cab sell for half as much as it does and that it last twice as long with no repairs.

The maintenance mechanic insists that accessibility is about the only thing of real importance in the design of the cab and front end sheet metal. His viewpoint is of great importance and must be considered as such. The designer will possibly never be able to satisfy completely his demands because of manufacturing cost limitations. However, it must be recognized that every single item that is involved in the design of a cab and front-end sheet metal must be examined carefully from the point of view of maintenance.

The driver's opinions and ideas are of very great importance to the designer. In fact, during the past few years, the driver has often influenced the operator considerably in determining make and type of equipment purchased. A well satisfied driver is the best salesman in the world for any truck manufacturer.

For many years, the cab of a motor truck was often treated somewhat as an afterthought. It was one of those necessary things that generally had to be provided by the truck manufacturer as an item of equipment. About all that was expected of a cab was that it provided a semblance of protection for the driver against the elements. No particular consideration was given the driver as long as he could get himself inside.

It was not felt that the driver needed a cab with a permanent top or windshield. The truck driver was considered to be a "guy who could take it." When doors were installed, they were only solid half doors.

The operator's driving posture was often very uncomfortable. The first trucks had hard seats with flimsy cushions containing few or no springs. The "lazy back" supported only a few inches of the driver's back, and bounced up and down on his kidneys with every jolt.

The interior of the completely enclosed cabs was generally very hot and stuffy in summer and quite cold with plenty of drafts in winter, and abounded in fumes from the engine during all seasons. In addition, the life of the cab was short and, of course, appearance meant little or nothing.

However, with the great advancements of passenger car body design in recent years, the truck driver began to demand more comfortable cabs which would more closely approach the driving conditions of his own passenger car.

A comfortable driver is a safe driver. When a man is too hot, too cold, or is "cramped up" in a cab, he is not physically able to drive safely. Also, it is only natural that a driver will take better care of a truck that is comfortable to drive and handsome to look at.

The cab of a truck is the driver's office and his working conditions should more closely approach that of a modern office. The average man spends less than one hour in his passenger car every day, whereas the truck driver spends eight hours a day in his cab. That is more time than he spends in his own home. (On an average he spends less than one hour a day in his favorite armchair.) Therefore something must be done to improve the driver's working conditions. In many cases greater vehicle cost is justified by doing a good job of satisfying the driver.

Naturally the designer must, at all times, be concerned with the viewpoint of the truck manufacturer. The manufacturer is generally desirous of completely satisfying the owner, the maintenance mechanic, and the driver, providing the production cost is low enough to permit a competitive selling price and reasonable profit for him and his dealers. In design "cost" will be repeated again and again.

There are additional important factors that must be taken into serious consideration by the designer, when he attempts to determine the requirements of a new cab and front-end design.

The wide variety of legal limitations imposed upon commercial vehicles operating over the public highways, governing their size, type, and weight distribution, has made it impossible to design one given vehicle which can be operated with any degree of efficiency on the highways of all forty-eight states. Cab and front-end design is affected by this unfortunate situation.

A number of conditions are imposed on the designer by the truck manufacturer over which the body engi-

Mack in the far future.

neering department has little or no control. Often these conditions have quite an effect on determining the requirements of a new truck design.

Company policy determines whether low price is to be the basic goal, or high quality at a definitely higher price. Whether the styling of a vehicle shall follow the passenger car trend or, perhaps, be something very new and original; or possibly carry out a traditional motif, or is to be based purely on the function of the vehicle, generally, becomes a company policy decision heavily influenced by the sales department.

Production estimates to be used as a basis for design must be obtained from the manufacturing and sales departments. Also, any outstanding features that are considered especially desirable by the sales department must be included when setting up the requirements for a new truck design.

The question of export business cannot be overlooked. The packing and shipping of knocked down vehicles must be considered. Right hand drive vehicles for export definitely affect cab design (for example, the design of the dashboard) and must generally be thought of as a requirement, the importance of which may be determined by the estimated export sales figures supplied by the sales department.

The manufacturing policy of the company must be borne in mind. Will the cab be fabricated and assembled in one plant or will parts of it be fabricated in several different plants and be assembled in one plant?

Whatever the selling price of the cab may be, the highest quality obtainable for that investment is essential. The cab structural problem must be recognized as being distinctly different than that of the passenger car or body. Since the chassis front of a truck is usually designed with the express purpose of allowing the frame to twist under extremely wracking conditions, the cab is subjected to considerably more stress than a passenger car body which is mounted on a stiff X member frame. A cab should be designed for 500,000 miles of service without major repair as compared with the probably 100,000 miles of vehicle service required of a passenger car body.

Full structural advantage should be taken of deep-drawn light-gage shapes, keeping cab weights and material costs down to a minimum without sacrificing strength. Every stamping should be carefully analyzed from the tooling standpoint in order to avoid blanking and restrike operations wherever possible. The number of parts in the cab should be reduced to a minimum in keeping with sound structural design and production limitations. The sequence of assembly and sub-assembly operations should be planned with extreme care to keep them simple and make them entirely foolproof so that there is less possibility of incorrect alignment. Full advantage should be taken of all possible interchangeability of parts within the cab. One cab should be used on as many vehicles as possible.

Improved driver comfort is a necessity, and of all design requirements one of the most important. The relation of the driver to the steering wheel and column, the tow board, the floor board, the pedals, the hand brake lever, the gear shift lever, the door glass regulators, the arm rest, and the bottom of the door window opening must be analyzed by mock-ups and actual test driving and added to the summary of information already gathered and published in order to arrive at a really desirable combination.

The seat itself must be given a great deal of consideration. There seem to be two theories on this subject. Some believe that seat cushions should be mounted in such a way as to provide an entirely independent motion in relation to the movement of the cab. Others are of the opinion that the seat cushions should be mounted so that they will move with the cab and that the cab should be mounted with considerable flexibility on the chassis frame.

The shape, position, depth, and material used in the seat cushions is best determined by actual driving test. Perhaps foam type rubber cushions without springs may eventually be the answer; at present, the cost of such a system is prohibitive.

Proper adjustment of the seat is an important item. Due to the length of time the truck driver spends behind the wheel, compared with the time the average passenger car driver spends in his car, it is obvious that it is even more important that each individual truck driver should be provided with a seat position that will best suit him. Not only must seat adjustments be provided that will satisfy the preferences of the driver, but the variation in driver size must also be taken into account. The driver should be able to change the adjustment of the seat conveniently while the vehicle is in motion, since it is often restful to change posture during a long haul.

Effective cab ventilation is highly desirable. For winter driving, thermostatically controlled heated fresh air forced into the cab would be a forward step. Effective ventilation in summer, with windows closed tightly during wet weather, is almost as important. Eventually, for summer driving it will probably be necessary to refrigerate the air brought into the cab.

The insulation and sealing of the cab should be effective. The driver should be well protected from engine heat and fumes as well as from the direct heat of the sun. It is important to prevent drafts and dust from entering the cab, when the windows are closed.

When the driver sits in the cab, he should enjoy the feeling of warmth and comfort that he enjoys in his own sedan. The "cold" atmosphere that has been so common in truck cabs should be avoided. It is realized that we cannot resort to the attractive cloth trims used in passenger car body interiors, but a careful choice of interior finish, together with the selection of a warm but comfortable color combination will help considerably.

Better driving vision is a necessity. The cab and front end should be styled so as to provide the greatest possible downward vision. The position of the front pillar must be carefully studied in order to reduce the blind spot to a minimum. A thoroughly effective system for defrosting not only the windshield but also

the door windows should be provided. In cold weather the pressurization of the cab with warm fresh air would perhaps solve the problem. Dependable, well-placed windshield wipers are vital. The visibility through the door windows should be well planned. Some cab door windows have been either too small or have been placed so that they have seemed like portholes. The position of the rear window in relation to the driver is important. This window need not be excessively large as long as its location is correct. Whenever possible, the cab door should be hinged forward so that the driver can open the door and lean outside for backing operations. In this connection, the Mack Truck Company has found it highly desirable to offset the cab on the chassis for better backing vision in special vehicles used in strip mining operations. However, under present trends in truck styling, the appearance of a highway type vehicle with an off-set cab would be very queer and strange. Such a possibility leads to new concepts and shapes in future truck styling.

Improved instrument visibility without glare is very desirable. The position of the instruments in relation to the driver's eye should be so planned that all possible obstructions are eliminated and the instrument dials should be as close to perpendicular to the line of vision as possible. The dials should be distinct and easy to read. Perhaps light signals may be found more effective than needle dials in some cases. The reflection of instrument panel lighting on the windshield glass during night driving should be avoided.

Convenient ingress and egress is sometimes difficult to obtain, especially when large vehicles are involved. Every effort should be made to improve this situation even though we may have to discard some of our conventional ideas. In this connection, the engine and chassis designer could help considerably.

There is no doubt that in some cases accidents are due to faulty brakes, bad tires, or failure of the steering mechanism. However, in a great many cases, drivers are accused of falling asleep. A big cause of fatigue can be found in truck noise. There are three basic sources of noises heard in the truck cab, viz.: the power plant, the transmission system, and road and wind noises. In addition to noises radiating directly from the engine, there are air-borne noises from the cooling fan, exhaust muffler, and carburetor intake duct. The vibration of the engine is transmitted through the engine mounts and, to a lesser extent, through the drive shaft, each of which in turn excites the frame and cab panels, so that they, through diaphragmatic action, set up sound waves in the driver's compartment.

Irregularities in the surface of the road transmitted through the wheels and spring suspensions cause recurrent stresses in the frame, which are then conducted to the cab panels. These panels are easily excited into vibration, tend to resonate, and act as diaphragms to create noise in the cab. This drumming can be reduced to a minimum by designing enough shape into the panels of the cab.

In addition, air-borne sounds are radiated directly from the engine and get through to the inside of the cab by transmission through dash and floor or by leaks through small openings.

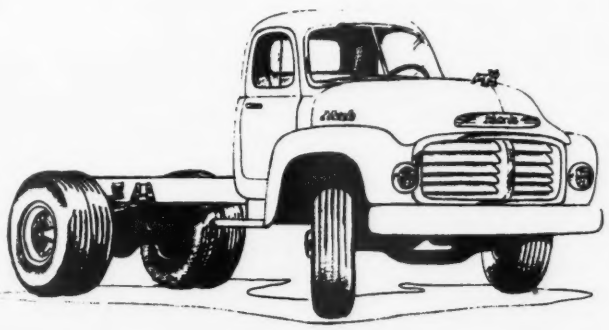
Elimination of bolted fastenings wherever possible, thus approaching a solid welded cab, will tend to reduce rattles, squeaks, and the like. If doors and windows are not properly designed, high frequency whistles and hisses become prominent at high speeds.

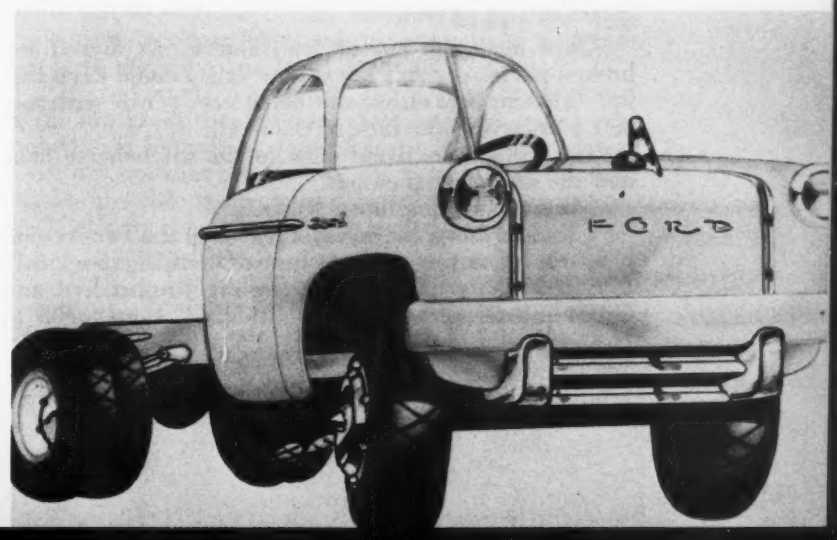
Cab noise levels can be reduced to less than half over the complete noise spectrum by the use of better sound barriers between the offending noise and the interior of the cab, reduction of panel noise by means of deadeners and dampers and also absorbent materials, isolation of the cab by means of vibration control mounting and absorption of noises within the cab by special surface treatment. The development of a more specific type of cab mounting should also result in a more comfortable ride for the driver and longer life for the cab.

When we stop to consider that the maintenance cost during the life of a commercial vehicle is often many times the cost of the original vehicle, we realize that everything possible must be done to facilitate the servicing of that vehicle.

Instruments are usually very difficult to reach for servicing, but with careful study, this condition can easily be improved. The battery should be so located that water can be added conveniently and removal of the battery must be a simple operation. The clutch, transmission, and steering gear should be accessible without requiring a major disassembly operation on the cab. Provision should be made for the convenient and effective lubrication of the door hinges. Door glass, windshield, and rear window replacement must be easy operations that can be performed quickly. The removal of the door glass regulator for repair or replacement must be as simple an operation as can be conceived. A worthwhile tool compartment should be provided in order to avoid the necessity of cluttering the cab floor with such items as chains, jacks, and tire tools. The sheet metal and cab should be designed so that oil and water can be positively checked with a minimum of effort, otherwise they will be neglected.

It would seem, then, that the requirements of truck cab and front end design are many and must be considered from a number of viewpoints. The design of a new cab and front end sheet metal is largely a matter of sound engineering and styling coupled with wise compromise.





Above, a redesign of the Model LJ in the "streamline" vein. At right, a futuristic Ford design based on the adoption of a horizontal engine.

reality

A Story in Two Parts: Part One

By Rudolph William Preisendorfer, '52

I think, therefore I am.
I am, therefore I think.

"Get up, you lazy son of a gun," Joe jabbed me as he woke me. "Come on, get up and get to work." I groaned and rolled over. I was dead tired. Last night's run was a rough one. "Let's go, let's go."

"All right, take it easy with my ribs, will you? I'm getting up."

Joe went out of the room, mumbling things about lazy people in general. I smiled as he left the room, and decided I had better get up. I flipped the cover back and felt the cold air in the room cause goose-pimples to rise on my uncovered legs.

* * * *

"You know, Joe," I said through a mouthful of mush, "number five has been giving me the willies ever since it started to act up a month ago for no reason at all."

"Ummmm-hih," he said as he read the paper and listened to my pratter at the same time.

"I looked at it yesterday again and it's still muttering. Did you notice anything last night?"

"Ummm-huh," he said. I just as well could have been talking to the coffee dispenser.

"I shut it off for a few minutes, and loaded number four in the interval, and I let the damn thing rest for a while. Then after five minutes or so, I turned her on again, and she just yammered and muttered the more. That thing is almost human."

"Ummm-huh," was the intelligent reply.

Splash!

"Why you dopey" — splutter, cough — "what in hell's got into you?"

"You weren't listening to me," I said in dead calm tones.

He wiped the dripping coffee from his face and slowly got up. Very deliberately, and with infinitely slow pace he moved toward the coffee dispenser.

"Now Joe," I said with quavering voice. "Don't get any ideas," he kept on moving toward the dispenser. "Now Joe, remember last time, I had to weld the dispenser back on the wall again."

He kept walking in that slow, awful deliberation.

* * * *

"Joe."

"Joe, get off me."

"Wise guy, hah?"

"Joe, I'm drowning in this goddam java, will you—splutter — will you — gurgle — will you — get — off — me? ——please?"

Once again he got off me, and I felt myself for broken parts. I don't know how long I could keep this up. That bruiser either was being very gentle with me, or I was having the luck of the devil.

He opened the drain cock in the kitchenette floor and the liquid soughed out.

"Get the welding unit, Rudy."

I walked down the corridor, through the twenty-odd bank-rooms, noting the busy hum of them unconsciously as I went along. I passed a growling number five, and left it muttering to itself. "Cranky," I managed to growl and sneer at it as I went by. I passed into the store room, and fetched the portable welding unit, and rolled it back to the kitchenette. Joe was mopping the floor.

He finished mopping the floor as I got the torch going.

"You know, Rudy, I have—hisss—hissss—night."

"I can't hear you, Joe."

"I said that—hisss—heard—hisss—night."

"I still can't hear you; talk louder, will you!"

"Shut that damn thing off," he yelled. The sound waves from his thundering throat almost blew the blue flame out.

I shut it off.

"Well?"

"I said," he started for the third time, "that I heard number five last night also. Damn thing has nothing wrong with it. I looked it over, even opened her up — couldn't find a thing wrong. All the circuits are perfect. Not a short in the whole thousand miles of wire — compatible feeding — smooth elimination — memory banks perfect. It's just cranky, that's all."

"Well, I'm glad to see you noticed it too; I thought I was going nuts. I took it apart and put it back together for I don't know how many times, and never saw a thing that could be screwing up the works."

"Something's fishy," was his brilliant observation.

"Look, Joe, you're not that tired, so's you can't come with me and give me a hand with it. Let's take a look at it together, and see if we can't dope this thing out. It's giving me the willies, as I said."

"Okay, let's go, but I am not promising you too much. I can just about keep my eyes open if I prop some match sticks in them."

"Thanks," I said, relieved that he was willing to tackle this thing with me. Joe was a good egg after all. All this fighting of ours was nothing but some much needed steam blowing off that managed to accumulate in this hell hole of monotony. Either we took daily whacks at each other, or we'd go around in a perpetual funk plotting each other's murder just for the hell of breaking the long unceasing flow of boredom that comes to the men operating these automatic observation-calculator outposts stuck in the middle of exactly nowhere.

We reached the calculator, and stopped in front of it.

"Just listen to the damn thing, will you!"

"Yeah, sounds like it's got a good case of indigestion," I added.

"Shut it off," he said.

I reached over to the control panel and shunted its load into number four. It stopped muttering instantly. It just squatted there now, and glowered balefully at us.

"I'll get the kit," Joe said as he walked off toward the control room.

"Now you just keep your shirt on, fivey, old girl, and poppa will rub your tummy, and get you well in no time." I was unscrewing the panel plates that were facing the corridor. The thumb nuts worked loose easily, indicative of the many times that they had been worked during these past days. I had the last plate

off, and the bewildering maze of wires and tube-banks shone broodingly from the deep interior.

Joe returned, carrying a service kit. He set it down on the floor, and opened it. He took out the primary circuit tracers and uncoiled them on the floor.

"Give me a hand, will you, Rudy?"

"Sure." I helped him lift the cables into position, and we connected them to the primary testing terminals.

He backed out of the opening as I was hooking the last terminal.

"Okay, Joe, switch on the B power source; everything's ready."

He flipped the switch on the inside of the panel openings that would run a steady test problem through the primary circuit. It was a simple n-dimensional integration problem that needed four interlocking answers from the punching mechanism of five. There was a short busy buzz — very healthy buzz — and five finished the problem with a snorting superiority that was the essence of perfect control and coordination.

"Perfect answer, and in standard time minus," said Joe, awed, as he inspected the rerouted punched card that was shunted out of the test delivery slot.

"I am telling you, Joe, I went over this test a hundred times or so in the past few days — old five here has nothing wrong that I can see. I am going nuts trying to figure out what in hell is bothering her."

We were deeply absorbed in the problem. Joe was stroking a stubble of beard that was a healthy eight o'clock shadow. I was absently rubbing my damp coveralls with one hand and scratching my unkempt hair with the other.

"Did you try reloading the memory column, or try clearing it and starting out with fresh data, say from number four?" asked Joe. "You know how sometimes they'll block — like seventeen did two months ago."

"Hell, yes," I answered. "I must have cleaned it out and repatterned it as many times as I've opened her up."

"Oh, well," he snorted. "Get out the secondary test problem. We'll trace this through to the last tube if we have to."

I reached into the kit and drew out the test circuit that would put five's logic, and free thought circuits through their paces. Joe was disconnecting the primary tester. I climbed onto the flat platform in the yawning mouth of the calculator that would enable me to roll right into its very gizzards with the test circuit so I could hook it up deep within its bowels. Joe could never fit into the back of the small room that was the inside of the calculator. It was a two man job to get back there and work. "Roll me in, will you, Joe?"

I stopped the platform about ten feet in, and groped for the switch on the wall of the side panel that would turn on a light so I could see what I was doing.

"You okay in there?" came Joe's voice, hollowed and muffled by the junk it had to pass through to get to me.

"Yeah, all set, pull me out."

Joe had the external B power source hooked up, and as soon as I was on my feet, he had it turned on. We both watched the test meters intently for any signs of trouble. Nothing. The circuits hummed away at the test problem in decision-logic, and in five seconds it was all over. Five was okay as far as I could see.

"Damn," muttered Joe, "what's wrong with this thing, anyway?"

"Oh, shut up, and give me a hand getting this stuff unhooked again." I was just as annoyed as he was.

I yanked at the connections with annoyance, and had myself drawn out of five's gut again.

"Never had a problem like this at Tech," muttered Joe as he stood before five and thought out loud. He lapsed into silence. He suddenly stopped stroking his young beard and stood stock-still.

"What's eating you?" I asked.

"Quiet!"

"What in he—"

"Will you shut that fat mouth of yours and use your ears and brain for a few minutes?"

I shut up and listened.

"You hear it?" he whispered.

"Hear what?" I asked stupidly.

"The muttering, idiot," he snorted.

"Muttering?"

"For God's sake, listen — listen — number four."

I held my breath and listened with all my might. There was something! It was a low almost inaudible whisper — something high up in the frequency scale, and it was coming from four!

"I hear it!" I whispered.

"Hmmmm," Joe grunted.

"It is getting louder, isn't it?" I asked.

"Yeah."

"Never heard it before, did you?"

"No."

Joe walked the few feet over to number four and stood directly before the corridor panels, and listened intently.

"It certainly isn't an overload hum," he observed. He was right. Even though we had shunted five's load into four, this overtone was not at all like an overload hum. This sound was a mutter, a similar silent version of five's muttering.

"Can't be an overload harmonic; I can hear that below the muttering," said Joe.

"Oh, God, now what?" I complained. "Is the whole place going blooey?"

"Let's get over to the central panel, pronto," ordered Joe.

"What's up, Joe, got an idea?"

"Yep," he said, and he was striding over to the central selector panel from which the room's calculators were fed problems when working in parallel or series. I followed him, puzzling what was in his mind.

"Why don't we switch five's load to some other unit and see if the muttering is observed with them also," I suggested.

"That's exactly what I intend to do," he answered.

We reached the board together.

"Let's see. Suppose we shunt five's problem over to six and idle five and resume four's normal load?"

"Okay," I said. "Here, let me give you a hand." I flicked back four's load, and switched the loads of five and six. We stood still not breathing at all.

"There it is." It was Joe again, he had sharper ears than mine. I strained, and now that I knew what I was listening for, I heard it. Six was rustling and muttering.

We switched and shunted five's problem through the entire battery of the twenty calculators in this room. Each time, the particular machine muttered and protested to the annoying load.

"It's external," concluded Joe. "The cause is not in the machines themselves. How could we have overlooked that before? I didn't hear it last night. I was tired, but not that tired. Yes, the trouble is somewhere outside the computer circuits."

"Let's try the pickups," I suggested. "They're next in line to the circuits."

"Okay." Joe packed up the kit and carried it back to control. I followed close behind, and before leaving the room, I took one last look back into it. The

machines were working away quietly, and five was once again protesting against its peculiar load.

We stopped off at the supply room, and Joe picked up his suit, and I grabbed a set of phones and ear plugs. As we walked along the central corridor toward the lateral airlock, Joe was donning his under-suit clothes. We arrived at the lock, and I helped him into the chest piece, and fastened it in the back. We hadn't said a word all the way along the corridor; each of us was grappling with the problem at hand.

"Give me a lift with the headpiece, will you, Rudy?"

"Up she goes." I helped him slip the half metal, half plastic headpiece over his head and shoulders, and screwed the back plates tight. He stomped around getting the feel of his heavy boots. I inserted the plugs of the head phone into my ears and plugged in the contact pencil at the side of the lock.

"Coming through," I said to him, as I heard his breathing in the headpiece.

"Check."

He pressed the lock stud which activated the inner door. It sighed open, and Joe went through. The door closed itself, the photos automatically registering Joe's presence in the lock. The lock gauges began to creep toward zero atmospheric pressure indicating the pumps were evacuating the lock chamber.

"Coming through?" I heard Joe ask.

"Check."

The red light flashed on in front of the lock panel, indicating that the outer lock door was unsealed. I could hear Joe's heavy breathing in the ear plugs stuck in my ears, I could hear him clanking around the side of the hull. The sound didn't come through the hull walls, but was conducted through Joe's boots, through his suit, and through the circuit to my ears.

"I am nearing five's pick-up," he announced.

"See anything unusual?"

"Give me a chance, will you?" he shouted. "What do you think this thing is, a bathing suit?" I could just picture him lumbering along the curved spherical outer surface of the hull, laboriously lifting and plunking his clumsy magnetic boots along the silver surface.

"Keep your breastplate on," I punned, feeling brave now that he wasn't within punching distance.

"I can't detect anything wrong with the suit kit," he reported. "Everything's registering fine. Pickup is within required frequency range, and static is normal. No broken connections or signs of foul play."

"Hold everything, Joe," I shouted. "I am going to unplug and run back to the bank room; hold still for a minute or so."

I unplugged the head set, and started at a run down the corridor back to the machine room. I headed for the central panel and plugged the pencil into the outlet there.

"Coming through?" I asked.

"Check. What's the idea?"

"This thing looks like an emergency, doesn't it, Joe?"

"Well — yeah — I — sure — but what's up?"

"I am going to disconnect Sector One and switch pick-ups. I'm going to shunt five's pick-up to each input circuit of the batteries in Sector One and see if we get the same thing there."

"Okay, I see your plan, go ahead."

"There it goes again, Joe," I reported, as I heard the first faint rumbling mutter from number one. I could hear Joe swearing out there, and muttering to himself.

"Hey, Rudy."

"What?"

"Switch Sector One's pick-up set into five."

"Boy, are we going to foul things up."

"Do as I say, boy."

I flipped the connections, shunting the pick-ups.

"Hear anything?"

I listened carefully. I couldn't hear a thing.

"No," I answered.

"Well, that tears it. I'm coming in. Meet me at the lock."

The red light blinked out, and a little later the dials crept back up to the green marks. The door opened and I stepped back; a sharply cold blast came in with Joe. As efficient as the defrosters in the lock were, Joe had rushed matters and didn't give them a chance to defrost him. A thin white coat of condensed and frozen atmospheric moisture covered his bulky suit. He started to unscrew the headpiece, and I tried to give him a hand. The screws were bitterly cold. He finally managed to get out of the suit, and into his coveralls that had been lying on the floor during his absence.

"As far as I can see now," he started, "the cause for all this funny business is not at all in the internal circuits, nor is it in the pick-ups. Further, as you say, Sector One's pick-ups don't give five the hiccoughs, do they?"

"No," I said.

"Well, then —" he hestitated, looking at me, expecting an answer.

"Well —," I started.

He cut me off: "Well, then the only thing left, of course, is a completely external, and foreign cause for all this trouble."

"And it's directional, too, the disturbance that the pick-ups are receiving, I mean."

"Yes. External, and directional. Let's see, five belongs to the third sector and that is a single, local pick-up on this run, right?"

"Right."

"What are the space numbers for five's hunting grounds?"

"I can't remember," I answered.

"What good are you, anyway?" he snorted in annoyance.

"Well, can you remember them?" I snapped back.

"No — no — I can recall all the space numbers we ever set into these counting cuties, but I'll be damned if I can remember just what five's numbers are."

"The same with me," I answered.

"Let's look in the directive."

We headed back into the control room. My puzzlement was deepening by the minute. And I could see that Joe wasn't exactly enjoying himself either. We reached control, and Joe headed for the cabinet, and fished around for a few minutes looking for the directive, which came from Base, and which outlined the research and observational projects alloted to each station. He finally found it. He took it down and opened it to SO–A/C–S–10998, that's us. He ran his fingers down the tightly printed columns and located five's space numbers for this current project.

"Well, here it is, all right," he said, and I could tell by his voice that he was looking at the numbers without apparently ever having seen them before. I came over to him and looked on. And *I* couldn't even remember having seen those numbers before.

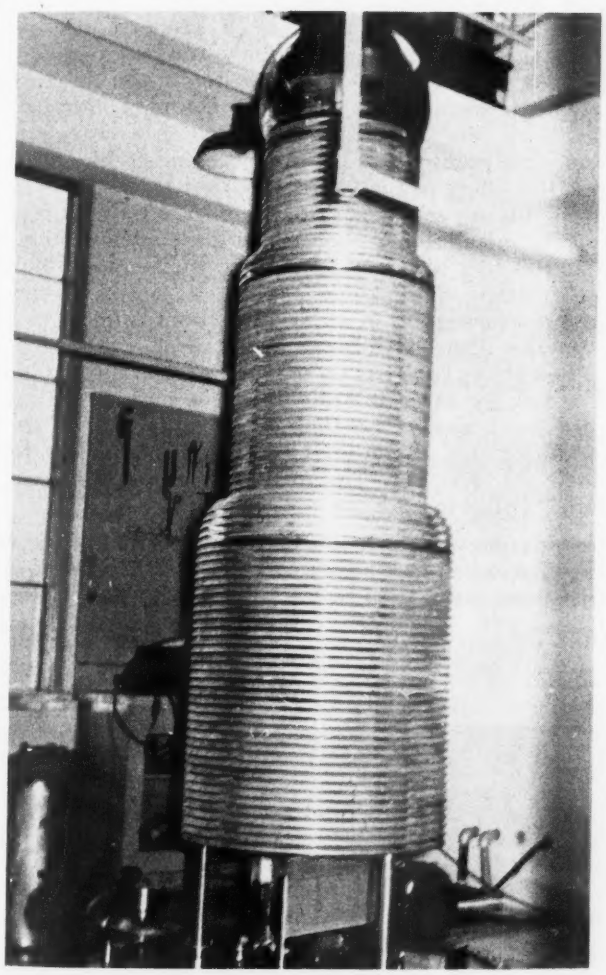
"How in hell did we ever set five up, then?" he asked of no one in particular.

"We could just have forgotten about it, you know how it is, Joe." (*Continued on page 26*)

cathode ray treatment of food

By Barry Stein, '53

Research on the subject of the action of cathode rays on food was started here at M. I. T. in 1943 at the request of the Quartermaster Corps, which was primarily interested in a more convenient method for the preservation and sterilization of foodstuffs. You may ask why it was so necessary to find a new method of sterilization, when there were numerous methods already developed. Freezing, dehydration, pasteurization, and, comparatively recently, ultra-violet sterilization are used. Each of these, however, presents certain inherent disadvantages. Freezing requires cumbersome equipment, a relatively long treatment period, and cold storage after treatment. Dehydration, so unpopular during the war, is also a long process, and although its space-saving effects are valuable, many vitamins are destroyed by such processing. Pasteurization, which depends on heating and rapid cooling for its effect, can be used only with liquid foods such as milk, which form only a minor part of our diet. Ultra-violet treatment is closely akin to that by cathode rays in its effects, but requires a much longer time. Cathode rays are superior to all of these processes in at least one respect: irradiation requires very little time — a point of interest to those who would apply the method commercially. Furthermore, the only precaution necessary for indefinite preservation of treated food is to keep it in a clean and airtight container.



This three-million-volt Trump generator, shown here with tank removed, produces the radiation mentioned in the text.

X-rays and gamma rays produce their effects on tissue by energizing electrons already in the tissue. The same effects would be produced if electrons of similar speeds could be produced in the tissue in other ways. Therefore, if the tissue was sufficiently permeable by an electron beam, it would be possible to bring about the same results by exposure to an externally formed stream of electrons. Now, cathode rays or beta rays are just that — a high-speed beam of electrons. The difference between cathode and beta rays is a small one: cathode rays are produced artificially by a suitable method, about which we will say more presently, while beta rays are natural radiations issuing from materials such as radium and radon, and to a lesser degree from artificially radioactive materials. The superiority of cathode rays over beta rays is immediately evident, since the former can be closely regulated in speed and power, and moreover, contain nothing but electrons. Beta rays, on the other hand, are intermixed with other types of radiation. X-rays have certain properties which render them less effective than cathode rays. They have a strong tendency to diffuse, and are inefficient in producing ionization in the tissue. In fact, only five per cent of the X-rays even reach the target, and for an equivalent dosage, a target must be exposed to them for about four hundred times the time interval required by cathode rays.

The Trump generator is a fairly representative cathode ray generator; a description of it is in order since it is the apparatus used at Tech for research on the subject of food sterilization. The Trump generator operates at a maximum potential of three and one-half million volts, and is based on the electrostatic principle made famous by Dr. R. J. Van de Graaff. The high voltage terminal is supported by insulating metallic equipotential spreaders, separated by glass spacers. A butyl rubber cotton fabric belt, ten inches wide, traveling at four thousand feet per minute, applies a negative electrical charge continuously to the high voltage terminal. The voltage is very closely controlled by varying the charge sprayed on the belt by corona points. The evacuated acceleration tube is mounted vertically within the generating column. A hot tungsten filament at the top of the tube serves as a source for the cathode rays, and the ray dosage is determined by the current from the filament. The insulating column of the tube, described previously, serves to spread the voltage evenly between the filament and ground. The electrons are therefore uniformly accelerated as they pass down the tube. At the base of the tube, the electrons must first pass through an aluminum seal before going on to the target, which is located forty-five centimeters from the exit, where they are focused by an axial magnetic coil. The sample to be irradiated is placed on a four-inch steel plate below the tube base.

The irradiation of food is itself very simple in principle, consisting merely of exposing the particular food

(*Continued on page 24*)

new lighting for the study room

The Use of the Plastic Ceiling in Lighting

By Costa Chitouras, '53

To the numerous methods for illuminating a room has been added a new type of lighting — luminous ceiling lighting. Although the advantages of this type of illumination have been known for the past few years, it has not come into widespread use because of the high cost of the diffusing plastic it requires. However, with the recent development of a much less expensive plastic by a local firm, luminous ceiling lighting can now compete with any other form of high quality lighting.

The plastic mentioned above was so recently developed that the installation described herein, installed by the author in his home, is the first home installation of this kind. Before proceeding with an actual description and evaluation of this type of lighting, it is worthwhile to discuss the properties of a good lighting system.

Up to the last decade, the sole criterion of a good lighting system was quantity of light, with no consideration for the amount of glare or the shadows present. However, it has been proven that glare and shadows are a potent cause of eyestrain just as is excessive contrast. A simple practice for elimination of excessive contrast, glare, and shadows in a particular installation is not to exceed a three-to-one brightness ratio; in other words, the brightest object in the room should not be more than three times brighter than the area illuminated (the study desk, for example), and the brightness of this area should not be more than three times as bright as the darkest object in the room.

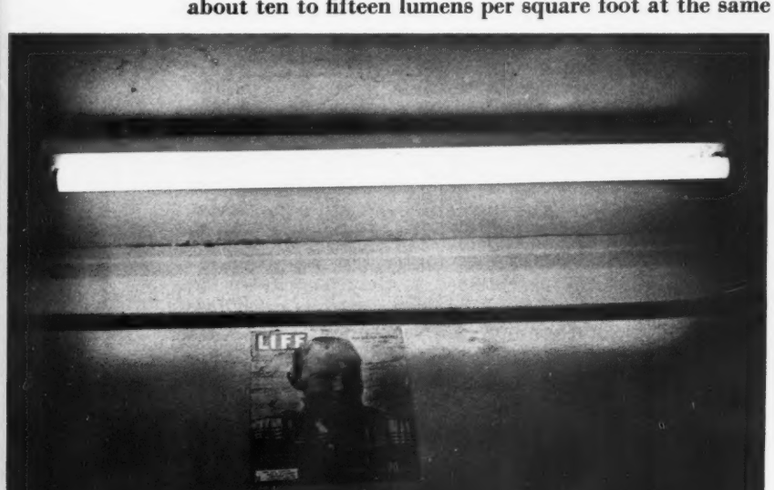
Up to this time no mention has been made about how much light is required for various seeing tasks. The Illuminating Engineering Society recommends from forty to fifty lumens per square foot for those doing close visual work over long periods of time as in studying. It is truly surprising to see just how far from this figure the values of illumination in most study rooms are. As an example, a 100-watt incandescent lamp placed in the center of the ceiling of a ten by ten foot room will give approximately five lumens per square foot at table height in one corner of the room and about ten to fifteen lumens per square foot at the same height directly beneath the light. One can plainly see that these values of illumination are a far cry from the recommended levels. An interesting fact concerning vision is that, as light is increased up to daylight values, 10,000 lumens per square foot, vision improves with increased illumination, provided the three-to-one criterion is maintained. Thus, in a properly designed installation, it is impossible to have too much light.

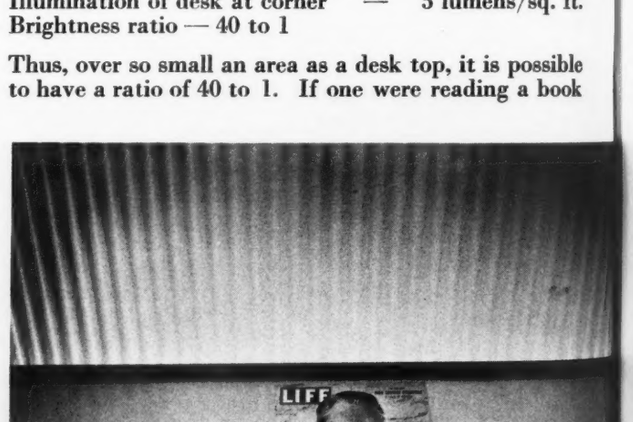
Most people would probably doubt the preceding statement, since it is a matter of common knowledge that, were very large lamps put into an average sized room, that room would be quite uncomfortable. However, this effect is due to the fact that the three-to-one criterion is not satisfied. Measurements made in many modern installations show brightness ratios ranging from 100 to 1 to 6000 to 1. Even with exposed fluorescent lamps, a brightness ratio of 50 to 1 is common. The brightness ratio in an average room is about equal to the last figure, still far from the ideal.

Tests have been run on the difference in illumination on a two by three-and-one-half foot desk top illuminated by a desk type fluorescent lamp. The lamp, containing two fifteen-watt tubes, was placed one foot above the desk top, the general position for such a lamp. Following are the recorded data:

Illumination of desk below lamp — 200 lumens/sq. ft.
Illumination of desk at corner — 5 lumens/sq. ft.
Brightness ratio — 40 to 1

Thus, over so small an area as a desk top, it is possible to have a ratio of 40 to 1. If one were reading a book





These two photographs give actual proof of the reduction in glare effected by the luminous ceiling. Notice the strips of glare in the photo on the left.

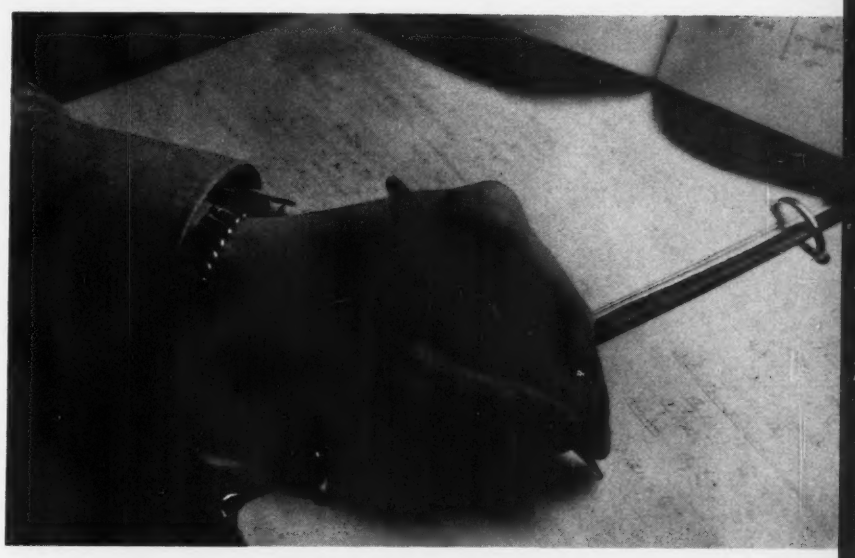
placed beneath the lamp and copying notes into a book near the edge of the desk, his eyes would have to adjust for illumination varying from five to 200 lumens per square foot. Such adjustments cause eyestrain and make a low brightness ratio desirable.

The three to one ratio is simply stated but difficult to achieve in practice with most conventional types of lighting systems. In fact, we may discard at the outset any kinds of bare lamps, incandescent or fluorescent, diffusing globes, and even the presently popular louvered ceiling. A louvered or louverall ceiling is one in which fluorescent lamps are mounted above a network of partitions which look like egg crates. The only way to achieve the ideal ratio is by employing an apparent source of large area and low intensity. In practice, the ceiling is the most practical large surface to use as the source of illumination.

There are at present two methods of making the ceiling the apparent source of illumination, and thus two methods of achieving high-quality illumination. The first method is to direct light up toward the ceiling from below by use of hanging luminaires, indirect floor lamps, or wall boxes. The light is then reflected downwards. The reflected light is that used for vision. This type of lighting is called indirect lighting. The second method of making the ceiling into an apparent source of light consists in mounting fluorescent lamps directly on the ceiling and then hanging a second ceiling of diffusing plastic a short distance below the lamps. The light passes through the diffusing plastic and is well diffused for seeing.

This latter form of illumination is called luminous ceiling lighting. The room in which the author has installed this system is seven by eight feet, with the ceiling white and the walls light green. (Light colored walls, furniture, and even desk tops, aid in approaching the three to one ratio.) Four forty-watt, 4500° K, white fluorescent lamps were attached, two feet apart, to the ceiling. Ten inches below the ceiling, a wooden border was nailed against all four walls, and two strips of wood so placed as to cut the second ceiling into three rectangles, two and two-thirds by seven feet in size. On these wooden supports were placed the plastic diffusion sheets. The result was one of the best lighting systems possible, especially for a study room. The brightest part of the room is, naturally, the plastic ceiling, which was measured as having an illumination of 125 lumens per square foot. The illumination at table level at any part of the room, corner or center, is 40 lumens per square foot, and at floor level, 20 lumens per square foot. Thus the brightness ratio, for a perfectly reflecting desk top, between desk top and ceiling is approximately three to one; and between desk level and floor two to one. Since brightness at a given level is the same at all points of the room, the brightness ratio, point-to-point on the desk, is unity.

Shadows are, for all practical purposes, absent in a room with luminous ceiling lighting. Notice the difference when an ordinary fluorescent desk lamp is used.



These figures show that low brightness ratios have been attained. In addition, however, there is no noticeable glare, even when glossy paper is used, and there are no shadows in the room, either upon the writing paper on the desk or a book being read.

In many recent installations the louverall ceiling has been used. This is, however, a bad choice, since a louvered ceiling does not prevent reflected glare, a cause of eyestrain. Besides this fact, when one looks up into a louvered ceiling he may see all the lamps and wiring, whereas the luminous ceiling installation allows no such view. Therefore the luminous ceiling has an esthetic advantage over the louverall installation and the indirect system, where a great many luminaires must hang from the ceiling.

The largest obstacle in the path of the lighting system described in this article has been cost. However, with the development of a less expensive plastic, the luminous ceiling now costs no more than a louverall ceiling. In the author's case, the cost of converting from the "old fashioned" incandescent lamp to the ultra modern luminous ceiling was not too great:

Fixtures, lamps, wire, etc.	$20.00
Diffusing Plastic	25.00
Wood, nails, etc.	5.00
Total	$50.00

Although this cost may appear high at first glance, in the long run it is cheaper than any other system giving a comparable quality of illumination. The author has used this lighting for the past four months, before which time he studied under desk type fluorescent lamps and incandescent lamps. After a few hours of reading under the two last, his eyes would become irritated. With the present lighting system such fatigue is entirely absent.

color tv fights it out

By Milo M. Backus, '52

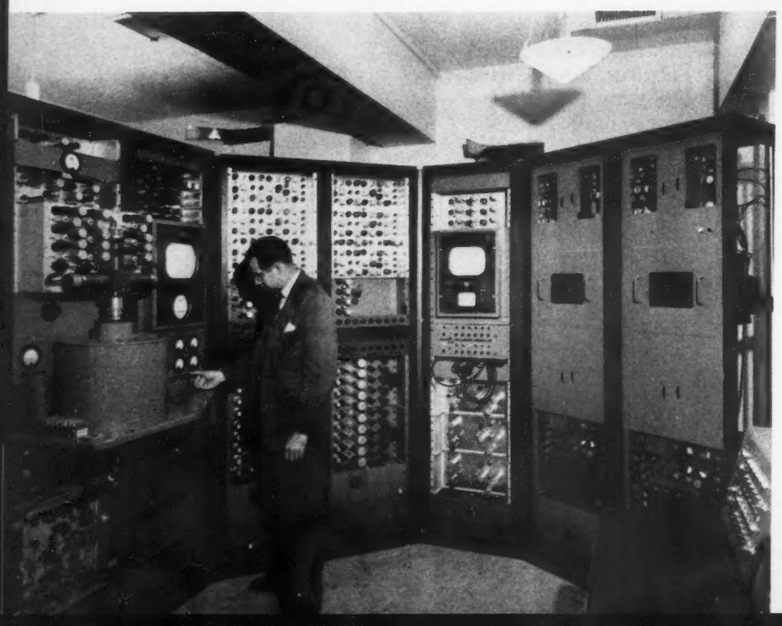
If the FCC grants permission, we may be watching television in full color within a year. RCA has developed a new, all-electronic color television system which is completely compatible with existing equipment. Color signals which produce a full-color picture on the new color receiver, also produce a black and white picture on the present monochrome receiver. Thus the objection that color television would make all present sets obsolete is removed. In the CBS color television system, which has been up before the FCC for the past three years, owners of monochrome receivers would have to convert their receivers at a probable cost of thirty-five dollars to view color programs in black and white, or seventy dollars for color reproduction. According to CBS testimony, however, while the lowest estimate for an RCA type receiver is five hundred fifty dollars, the CBS type color receiver would only cost about fifty dollars more than present monochrome receivers.

In black and white television, the picture is produced by a small dot of light which varies in intensity as it moves across the viewing screen in regular lines. Five hundred twenty-five of these lines cover the entire picture area. Thirty of these complete pictures per second produce the effect of a moving picture. The dot of light is produced by an electron beam directed against a phosphor. As the electron beam moves across the screen the television signals are used to vary its intensity.

The CBS color television camera consists of a single image orthicon tube, similar to those used in monochrome television cameras, behind a rotating disc, divided into segments which are red, blue and green color filters. When the red filter is in front of the tube, a picture of the red intensities of the scene is recorded. 1/144 second later the blue filter is in front of the tube. As the color disc revolves a rapid succession of red, blue and green intensity pictures are picked up. The color signal is picked up by the receiver, which has the same setup, an ordinary monochrome kinescope behind a rotating color disc. When the red intensity signal is producing a monochrome picture on the kinescope, the red filter is in front and a red picture is produced on the viewing screen. The retentive properties of the retina cause this rapid succession of red, blue, and green pictures to be reproduced in the brain as a steady full-color picture with all color hues. For instance, a yellow ball would be shown as a succession of blue and green balls. These would combine to produce a yellow ball. The color disc in the receiver must rotate at the same velocity as the disc in the camera. The discs must also be in phase; the red filter must be in front of the kinescope when the red intensity signal is projected. If not, the red intensities would be reproduced on the screen in green, the blue in red, and the green in blue, which would result in a rather odd picture.

In order to avoid color flicker, each successive picture consists only of the odd or even lines of the field. Thus six color changes are required for a complete full-color picture. Since there are 144 color changes per second, there are 24 full color pictures per second in the CBS color television system. The number of lines per picture is 405, as compared to the black and white standard of 525. The field frequency is 144 per second, as compared to the black and white standard of 60. These differences explain why the present monochrome receiver must be converted to reproduce CBS color signals in black and white. After this conversion, a rotating color disc in front of the kinescope would reproduce those pictures in color.

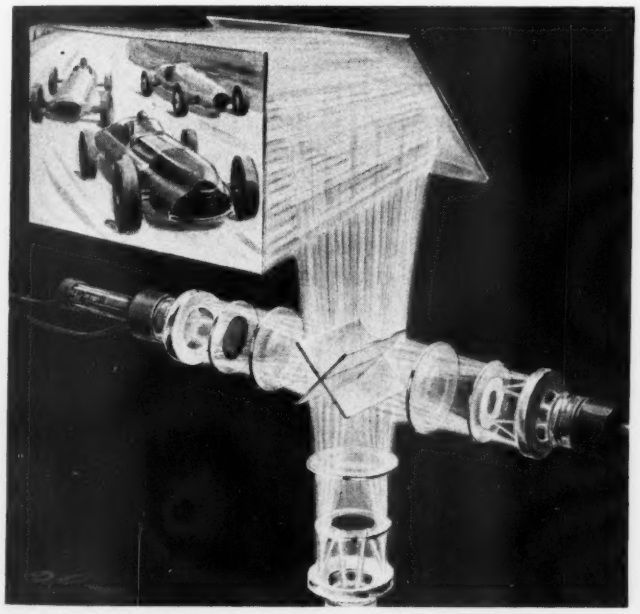
Color television direct-view picture reproducing system using three kinescopes.



General view of equipment, including studio control units, for the RCA all-electronic color television system.

The RCA color television system accomplishes the mixing of the three primary colors in an entirely different manner. The three primary color intensity pictures are projected simultaneously from three different kinescopes. The three pictures are optically superimposed upon one another to produce a full color picture with all the varying hues. A diagram of this system is shown above.

A block diagram of the broadcasting station for the RCA color system is shown in Figure 1. The studio apparatus provides three signals, one for each of the primary colors. Each of these signals may contain frequency components out to a maximum of four megacycles, and in addition an average or dc component. For one signal routing of Figure 1, each color signal passes through a low-pass filter which eliminates frequency components above two megacycles. The three low-frequency signals, G_L, R_L, and B_L, are then sent into an electronic commutator or sampler. At the same time, the three signals are combined in Adder no. 2. The resultant signal passes through the band-pass filter, from which a signal which contains frequencies between two and four megacycles is put out. In Adder no. 1 the described signal, the signal from the sampler, which will be explained in the next paragraph, and the standard synchronizing signals from the synchronizing generator, are added. The resultant signal is applied to the modulator of a conventional VHF or UHF television transmitter, which sends the signals to the antennae of the receivers.



This drawing shows the system used in producing color television for projection via the RCA system.

An explanation of the electronic sampler will explain the basic principles involved in the RCA color television system. In the sampler, each color signal is sampled for a very short time, 3.8 times 10^6 times per second. Figure 2a shows the output of the sampler due to the green signal only. The green channel signal is sampled every 0.263 microsecond ($0.263 = 1/3.8$). At a time 0.877 microsecond after a green sample, a sample is taken of the red signal. The composite output of the sampler consists of a superposition of the green, red, and blue trains of pulses or samples. The narrow green pulses of Figure 2a are smoothed by the low pass filter following Adder no. 1 to give the result shown in Figure 2b. This wave consists of a dc component, which is the average of the pulse sample, plus a sine wave which has a frequency of 3.8 megacycles. The sine wave and the dc component change together, as the

The mirrors shown in this photo of an RCA color camera permit light of one color to reach each lens.

green signal changes in strength, in such a way that the signal of Figure 2b always passes through zero at the same interval of time after the peak regardless of the strength of the green signal. The smoothed sample of the green signal may be expressed as: $\frac{6(t)}{3}\left[1+2\cos(2\pi ft)\right]$ where $G(t)$ is the green signal as a function of time, and f is the sampling frequency, namely 3.8 megacycles. Thus the smoothed green sample goes through zero 120 and 240 electrical degrees after the signal has reached its maximum value. The smoothed red and blue signals are shown in Figures 2d and 2f.

The result of combining these three signals is shown in Figure 2h. It should be noted in Figures 2b, 2d, and 2f that when any one color signal out of the filter reaches its maximum value, the value of the pure green signal at the time of sampling, when the other two responses are crossing the zero axis. Thus when this composite signal is reproduced in the receiver, it can be sampled at the same frequency of 3.8 times 10^6 per second, to reproduce the red, blue and green color signals for the receiver. Again as separate signals, these can be applied to three different kinescopes to provide three simultaneous pictures of the three different color intensity pictures.

The action of the system in the presence of a varying color may be illustrated by means of Figure 3. In Figure 3a, the three color signals are shown as they enter the sampler, with the appropriate sampling pulses as they come out of the sampler indicated by vertical lines. The result of combining and smoothing these three pulses is shown in Figure 2b.

The RCA system is called a picture dot sequential system, because instead of having three sequential fields of different colors on the viewing screen, it employs three sequential dots of different colors. In each color kinescope the little white dot of light "goes out" for twice the distance that it is on for the scanning of a line. This is due to the fact that the signal which is sent to

(*Continued on page 32*)

tech engineering news

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from the editor's notebook

It Doesn't Bother Me, But...

When the water frozen in the New Library's patio thawed, leaks were discovered. Since the stacks beneath were liable to be damaged, the inherently leaky surface was repaired. . . .

There is an eleven hundred dollar monument to something on the Building Seven steps. So far the children of Cambridge are the only ones who have found a use for it. . . .

Twice last fall, the pavement in front of the Dormitory office was ripped up and laid again. . . .

Then how about the "open door"? . . .

No doubt there are many other examples of poor planning about the Institute. These four are those which have been played up, but where some are so obvious, there must be more.

Not that the administration is wasting our tuition; tuition money goes for just that; but the funds for the aforementioned endeavors came from some place. M. I. T. is currently engaged in raising twenty million dollars to insure its economic independence and finance its expansion. No one will contest the worth of the goals. However, it looks from here as if someone has gone on a spree, "Let's get this, let's build that," and in his enthusiasm has discounted need or efficiency as of minor importance. No doubt the Institute will look very pretty when the building is done, but there may be a sour taste left when an itemized accounting comes through.

It might be well for those who plan for M. I. T. to go a little more slowly and a lot more carefully. There aren't many around who will contribute several thousand so that a pavement may be laid twice when once is the usual procedure.

K. K.

Our Writers...

Students have probably noticed the diffuse lighting system installed by the Institute in one of the classrooms. COSTA CHITOURAS, '53, who was enthusiastic enough about this innovation to install it in his own home, gives our readers a good resumé of the whys and wherefores. JOHN MATHIS, '53, and SHERWIN KALT, '53, went on a conducted tour of the Spectroscopy Laboratory. Not everyone can do this, we hear, so you can read their article in this issue. RUDY PREISENDORFER, '52, whose "Day, the Eighth" appeared in December, can be classified as a real devotee of science fiction. It's said his room is stacked high with manuscripts — we hope you like this sample of his work. A field much needing review is color television; dependable MILO BACKUS, '52, did an admirable job of digging out the facts. Trucks and automobiles from the pen of CHARLIE JORDAN, '49, have always made a hit, so we didn't hesitate to use his thesis as a basis for an article on Mack trucks. The thesis is quite remarkable, by the way. The article on cathode ray treatment of food was suggested by Dr. Samuel Goldblith of Food Technology. BARRY STEIN, '53, got the scoop on this new and perhaps revolutionary development.

Our Apologies...

We promised our readers the results of our poll in this issue. As is evident, they aren't here — the job of tabulating has proved bigger than we originally expected. Some extremely interesting results are forthcoming, however. The staff would like to extend its thanks to those students and staff members who co-operated to give a better representation than we had expected — about seventy per cent of the undergraduate body.

PROBLEM — You are designing a circular saw. The blade must have horizontal, vertical, and angular adjustments. Your problem is to work out a drive for the blade that permits this three-way adjustment. How would you do it?

THE SIMPLE ANSWER — Use an S.S.White flexible shaft to bring power from the counter-shaft or motor to the blade. There is no simpler mechanical means than a flexible shaft for driving parts which must be adjustable. And simplicity in design means economy in production.

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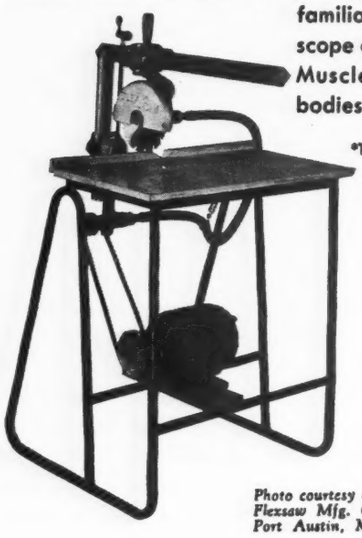

Here's one prominent manufacturer's solution to this problem.

Photo courtesy of Flexsaw Mfg. Co. Port Austin, Michigan

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spectroscopy at m. i. t.

(*Continued from page 7*)

parator. This instrument is designed to compute and record wave lengths and intensities of spectral lines obtained on transparent photographic plates. The plate is slowly passed across a narrow beam of light projected onto a photocell. Each spectral line on the plate causes a decrease in the intensity of the light which hits the photocell. The cell continuously records this intensity; when the minimum is reached, showing that the spectral line is at its maximum density, a circuit is triggered which records the wave length of the line to seven significant figures. The wave length is determined by accurately locating the position of the line on the plate.

The automatic comparator saves an enormous amount of laborious computation. It requires only two minutes to record data from a plate which may contain one thousand calculations to seven significant figures. So efficient and accurate is the machine that many spectroscopic laboratories, including that of the National Bureau of Standards, send plates here to be analyzed.

This comparator, the only one of its kind in the world, was developed by Dr. G. R. Harrison, Dean of Science at M. I. T., while he was engaged in compilation of the internationally famous M. I. T. Wavelength Tables. For this work he was awarded the Rumford Medals of the American Academy of Arts and Sciences in 1939. During the war, Dean Harrison was engaged by the government as chief of the Optics and Physics Division, Office of Scientific Research and Development. Professor Harrison served as director of the spectroscopy laboratory until his appointment to the post of Dean of Science in 1946.

The present director, Professor Richard C. Lord, served as a Technical Aide to the Optics Division of the National Research Committee during the war, and was one of the originators of the "Azon" guided bomb. He later served as a member of the Research and Development Board's Panel on Infrared. He is now directing an Office of Naval Research project on the use of infrared spectra in the determination of molecular structure.

Under the direction of Professor Lord, the laboratory will continue its basic research on the structure of matter. The effects studied in the laboratory may find important applications in the fields of physics and chemistry. Already spectroscopy has found uses in processes directly affecting the welfare of a large part of our society. It plays a major role in industry through its efficient and rapid analysis of traces of unknown materials. For the same reason, it is used in modern crime detection techniques. Thus we see that the spectroscopy laboratory has possibilities of greatly increasing not only man's knowledge of science, but his immediate comfort and safety.

solution to the sub problem

The crux of the thing is to realize, as the mate did, that the sub has a constant velocity — speed and direction. Now the mate didn't know *where* the sub was headed; he only knew its position at one instant and its rate of departure from that position. But since its path is a straight line, the sub must always be on a circle whose radius is its speed times the elapsed time after being seen. Assuming that the speed of the destroyer is greater than the sub's, a sure method of interception is to get on this circle, and then to adjust the radial speed to that of the sub so as to *stay* on it. The resulting course turns out to be a logarithmic spiral, so unless the helmsman has had M11, he *might* have trouble staying on course.

In safe hands . . . even at 60 below!

DO YOU REMEMBER when winter meant storing the family car till spring? Not so many years ago, a car owner's fear of an ice-shattered motor was a dread reality . . . if he *didn't* drain his radiator and store his car once cold weather hit!

What was needed—acutely—was an automobile anti-freeze that would prove always *dependable* yet *economical.* One that would hold up under any operating temperature. That wouldn't foam and boil away. That would resist rust and corrosion to the *nth* degree.

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Polar Ice & Fuel Co.'s 70-Ton System at New Albany

62-Ton Plant of SERV-ICE and Coal Co. at Columbus

SIX 1-MAN ICE PLANTS NOW OPERATING IN INDIANA

The world's first large ice-making system to be operated by one man, working only one shift, was started at Indianapolis in February, 1945. This (shown above) has made 42 tons of ice every day for over 1,500 consecutive days—a record, and equal to over a billion ice cubes!

46-Ton 1-Man Plant of Muncie Ice & Coal Co.

Five other Frick 1-man plants have since been built, at Muncie, New Albany, Columbus, Indianapolis, and South Bend. The largest of these makes 108 tons daily. All operate with remarkable economy. A 100-ton 1-man Frick plant is also under construction at El Paso, Texas.

52-Ton "Zero" Plant, Indiana Ice & Fuel Co., Indianapolis

The Frick Graduate Training Course in Refrigeration and Air Conditioning, Operated over 30 years, Offers a Career in a Growing Industry.

South Bend Brewing Co.'s 100-Ton Tanks

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Also Builders of Power Farming and Sawmill Machinery

cathode ray treatment of food

(*Continued from page 15*)

being sterilized to cathode rays of various intensities and endurance. It is, of course, necessary to have a unit for measuring dosage. The standard unit of radiation dosage is the roentgen, defined in terms of the amount of ionization produced by X-rays or gamma rays. It is therefore not possible to measure intensity or dose-rate of cathode rays with this unit. However, it is possible to set up an equivalent unit in terms of the roentgen as follows. If the energy lost by ionization in the tissue is the same as the energy loss of one roentgen of gamma radiation absorbed in air, the dose is spoken of as one roentgen-equivalent-physical (rep.).

So far, only certain foods have been tested: sugar, prune juice, dried apricots, prunes, raisins, coffee, corn oil, haddock, wheat, mackerel, hamburg, milk, apple juice, orange juice, and certain vitamins. Prune juice, dried apricots, and prunes are bleached by radiation, but the flavor is unchanged and the color returns partially upon standing. Sugar turns brown, but its water solution is colorless, and both flavor and sweetness are unchanged. Raisins are bleached and their sweetness is lost on irradiation. The color returns partially, but the flavor change is evidently permanent. All forms of coffee are bleached and the caffeine is destroyed, thereby changing both the flavor and aroma. Hamburg, the only meat tested, is changed only in flavor, but this change is volatile. In other words, cooking restores the original flavor completely. Both apple juice and orange juice are unchanged by radiation of less than 500,000 rep., but complete sterilization does not take place until above this dosage. At 750,000 rep. both flavor and color are changed, but irradiation of the juices in a frozen state eliminates this completely. Corn oil is oxidized by radiation, thus giving the effect of rapid spoilage. Raw milk takes a very high dosage for sterilization, and the flavor is changed as well. It is similar to orange juice, however, in that irradiation in the frozen state eliminates the flavor change.

More important than the flavor or color change, however, is vitamin loss. Ascorbic acid, riboflavin, and niacin are particularly sensitive to radiation. A dosage of 1,000,000 rep. destroys sixty per cent of the riboflavin in milk, but this effect too is largely prevented by irradiation in the frozen state. Enzymes are extremely resistant to cathode rays, requiring approximately ten times the dosage in rep. as bacteria for the same degree of destruction. It is found that vitamins exert a protective effect on each other, so that two or more vitamins together are, in general, more resistant than they would be separately. Furthermore, experiments indicate that the more complex or concentrated the substance, the less its destruction upon irradiation.

Before we can understand completely why radiation has the above-mentioned effects, much more research must be done, but it is possible to get some general ideas on the subject. When most materials are exposed to radiation, a chemical change takes place. This is due to the fact that electrons are expelled from the substance, thus changing the structure, and therefore the chemical composition. This explains to a large degree the flavor and color changes. For example, in prune juice and dried apricots, there is a chemical called 5-(Hydroxymethyl)-furfural which is changed by radiation to levulinic acid. The cause of the destruction of enzymes and bacteria may also be due to chemical and structural changes in the substance. Radiation can affect a material in two different ways, directly and indirectly, and it is important to know which way in any particular case. Direct action is the immediate action by cathode rays on the substance under test, while indirect action can be either secondary ionization (ionization produced by electrons emitted by other substances which were directly ionized) or a chemical change brought about by the new chemicals and radicals produced by direct ionization of other substances, such as the medium. If the action is direct, the results of irradiation will be the same no matter what foreign matter is present, while if the action is indirect, a change in medium might well produce different results. Most foodstuffs seem to be acted on indirectly, while vitamins such as riboflavin are acted on directly. It is interesting to note that indirect action is approximately linear with respect to dosage, and that direct action is exponential in form.

I doubt that it will ever be practical to use cathode ray sterilization in the home, since the equipment is rather expensive, and it is necessary to control the dosage quite closely for different foods. In industry, however, there are great potentialities. To name just one, food and cans might both be sterilized by this method, thus eliminating the tedious heating method now in use. Also, it would be possible to can many foods which cannot be canned by present methods because of vitamin loss or flavor change. Cathode ray sterilization would also be valuable to the armed forces, because of the great rapidity of the process. On some foods it cannot be used at all, but there are many more susceptible of treatment. Do not expect to walk into your kitchen one day and find a newly installed cathode ray generator; but you may hope to find your canned foods improve in taste and increase in variety.

Newsworthy Notes for Engineers

ACTUAL SIZE

Mighty Midget of Microwaves

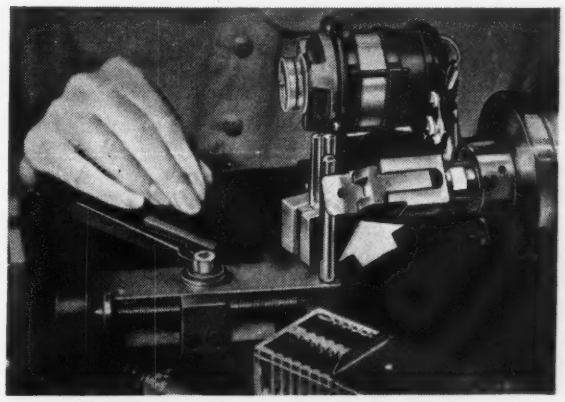
This little electron tube is called the 416A. It's the very heart of the latest radio relay repeater equipment for telephone and television transmission over long distances. Bell Telephone Laboratories scientists designed it—with elements spaced five times closer than in any previous microwave tube—and made the first samples under laboratory conditions.

Could such a tube ever be factory-produced in quantity? It seemed almost impossible—but Western Electric engineers tackled the ticklish problem. Here's the sort of thing they had to deal with.

Between the grid, which controls the flow of power in the tube, and the cathode, which produces the electrons, must be a space 6/10 thousandths of an inch. The oxide coating on the cathode must be 5/10 thousandths of an inch—no more, no less. The grid wires —3/10 thousandths of an inch in diameter —must be wound around the grid frame one thousand times to an inch!

The tiny parts would have to be made with laboratory precision. Much of the work would have to be done under microscopes. All parts would have to be kept surgically clean—for a speck of lint or a trace of perspiration could mar the efficiency of such sensitive tubes. New machines would have to be designed—new techniques developed—people trained to assemble the minute parts with utmost accuracy.

Could it be done? Well, Western Electric is making 416A tubes in quantity today—and with an amazingly low percentage of rejects.

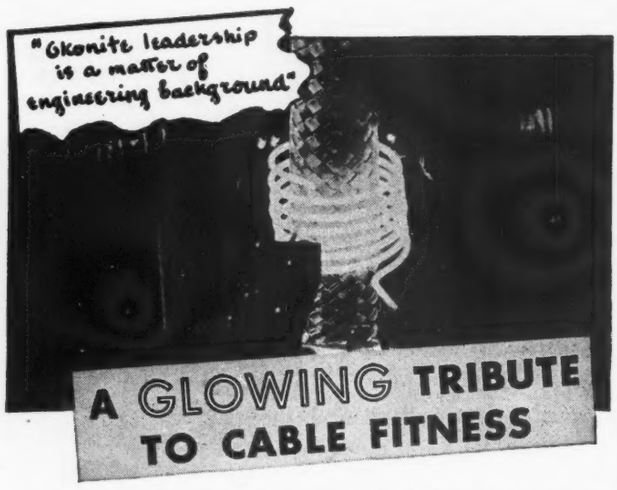


This machine winds wire 1/8 the thickness of a human hair around the grid (arrow)—1000 turns per inch—maintains tension of 60% of wire's breaking strength.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

Engineering problems *are many and varied at Western Electric, where manufacturing telephone equipment for the Bell System is the primary job. Engineers of many kinds—electrical, mechanical, industrial, chemical, metallurgical—are constantly working to devise and improve machines and processes for production of highest quality communications equipment.*



Is a cable covering flameproof? Will it resist high temperatures when it comes to actual service?

Long before a cable is manufactured, questions like these are answered in the Okonite laboratories, proving ground and in various testing departments of the Okonite plants. The picture above shows a flame test. The measured current that makes the coils glow makes it possible to reproduce test after test without variation. The Okonite Company, Passaic, New Jersey.

OKONITE SINCE 1878 5238

insulated wires and cables

reality

(*Continued from page 14*)

"No, I don't know how it is, Joe," he mimicked my voice. "I've never forgotten a number I ever set into one of those blasted glass and wire heaps out there, and neither have you," he glared at me. I nodded, and strange doubts about our stability began to creep into my mind. I could see him working on the idea too.

"No, I don't think it's that, Rudy," he said gently. "There is something external here too, just like the trouble five is having is external in origin."

"Do you think we should notify Base?" I ventured.

"Well — what do you say?"

"Dammit, man, I'm asking you!"

"N — no — no, I don't think so. I want to look into this a little more before I have any of the big boys coming around and finding that we have trouble right before us and don't even see it. This thing has been before our eyes for — well — you say you've noticed it more or less now for about a month — right?"

"Yes."

"Hmmm. How did it start out? Was it as bad as it is now?"

"No. It came gradually. At first I thought I was just hearing things, or that five had a little more of overload hum than designed. I think that I really started to notice it about a week ago, a day or so after I opened five for the first time."

"Yeah," Joe mused, stroking his stubbled chin. "Just about the same with me. Didn't bother me much either, until you started harping on it just about an hour or so ago, when you were eating." He thought for a few minutes more, and started to frown. The frown changed into an involuntary yawn. "I am going to sleep on it, Rudy. — Sorry, but I'm no good in this condition. You're fresh. Think about it, and tell me any of your conclusions tonight when you relieve me."

"Goodnight, Joe."

"Goodnight, goodnight," he yawned in reply, and ambled out of control and down the corridor to his cabin.

I sat down in the lounging chair, and settled myself. I treated myself to a cigarette, and ran over all the events of the past hour. I was probably no better off than Joe. It just didn't make sense; the whole thing was without precedent. I sat and brooded out my entire shift, and only occasionally visited the banks and made manual checks — and they were made absently and automatically by months of unchanging routine. I spent the last hour brooding over the problem as I sat in control — and got nowhere.

The chronometer on the panel said it was "morning," and that my shift was over. I crushed out my cigarette, and got stiffly to my feet. I stretched and yawned, but was not too tired. I felt as if I could go through Joe's shift without too much trouble. I went to the wash room, cleaned up, switched to a pair of fresh coveralls, and headed for Joe's cabin to start our idiotic but almost welcome ritual of waking each other up.

"Joe," I shook him gently.

"Hummmnnf?"

"Get up, Joe."

"Arrammnnff!" he grumbled out, and managed to turn over and cover himself up to his ladle-like ears.

"Get up, you lazy son of a gun." I imitated him, and at the same time tested the flexibility of his ribs.

"For Pete's sake, Rudy, I'm getting up. Lay off."

"That's enough dreaming about Helen for a while," I mused.

"Helen! — Hel —" He cut himself off, as if her memory had chastised him in mid-swear. "Okay, I'll get up, but I haven't been dreaming about pleasant things like Helen —"

"Joe —" I started hesitantly.

"Well?"

"I've been thinking about it all night, and I haven't gotten anywhere."

"I have been dreaming about the things, Rudy." He went white with the memory of it.

"Like what?"

"Oh, I can't place my finger on it definitely — I just had the feeling that everything just wasn't right."

"What do you mean by 'everything'?"

"Not only the machines, but just everything in general —" he continued to be enigmatic.

"All right," I said, "get up and dressed. I'll have the dispenser fixed by the time you have that black wire mat on your face sheared off."

I left the cabin and headed for the kitchenette, and on the way I stopped off at the Teleprinter to pick up the daily paper, which was beamed in from Base. I entered the little cubicle that was set aside for it and other beam transmitters and receivers which connected us to Base, and civilization. The Teleprinter's pilot light was out. And there was no paper in the receiving tray.

"Oh, God!" I must have voiced loudly, for:

"Now what?" Joe lumbered in the room, still having half his face smeared in shaving salve. "What's wrong now?"

(*Continued on page 28*)

Deep are their **roots**

With television, you see far beyond the horizon. Radio brings you sounds from around the world. Electron microscopes peer deep into the world of the infinitesimal.

These, and other "leaves" on our new tree of knowledge are rooted in creative research—as carried out at RCA Laboratories in Princeton, N. J. Here, scientists seek new scientific principles, improve old ones, put them to new uses.

Already on their achievement list are hundreds of basic developments in electronics, television, radio, electron tubes, radar, and recorded music. RCA research works continually to give you better products.

Examples now working for you include: Image Orthicon television cameras, television picture tubes, compact portable radios made possible by tiny RCA electron tubes, the 45-rpm record-playing system with the fastest record changer ever devised and distortion-free records.

Research in your behalf: Creative research into new principles is another way in which RCA Laboratories work to improve your way of living. Leadership in science and engineering adds *value beyond price* to any product or service of RCA and RCA Victor.

Examples of the newest advances in radio, television, and electronics—in action—may be seen at RCA Exhibition Hall, 36 West 49th St., N. Y. Admission is free. Radio Corporation of America, Radio City, N. Y. 20.

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

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- Design of component parts such as coils, loudspeakers, capacitors.
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Also many opportunities for Mechanical and Chemical Engineers and Physicists.

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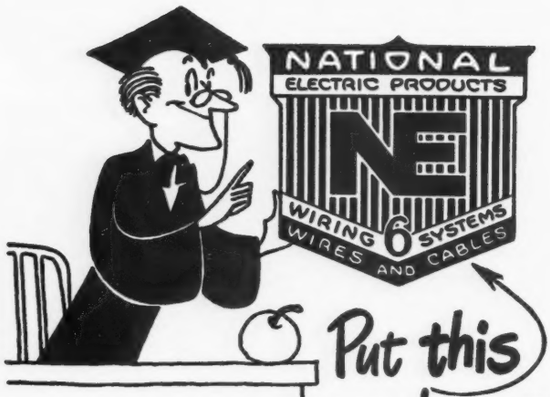

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Sometime you'll be looking for something racy in raceways. Or you'll want asbestos cable that really beats the heat. National Electric has all that plus everything else you'll want in the way of a *complete* line of electrical roughing-in materials. Everything in the field of wires, cables, conduit, raceways and electrical fittings.

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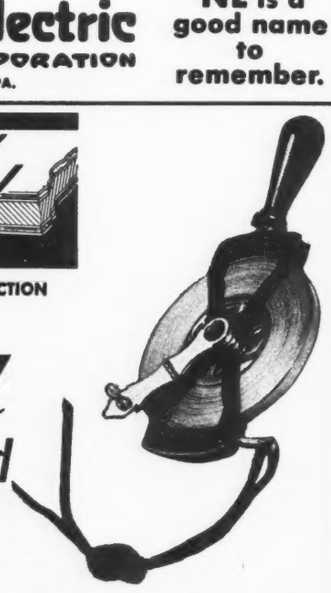
NE is a good name to remember.

DIAGRAMMATIC CROSS-SECTION VIEW OF A

LUFKIN
Chrome Clad Steel Tape



This cross section view gives you the "inside story" of the most outstanding development in steel tapes in years. (1) Hardened steel tape—tough—flexible—kink-resistant. (2) Rust resistant coating. (3) Multiple coats of electroplating. (4) Hard, smooth, non-glare chrome plating. Will not crack, chip or peel. (5) Jet black markings—easy to read in any light—bonded to steel base—sunk below chrome surface protecting them against wear.

Ask your distributor for them or write for complete details on Lufkin Chrome Clad "Super Hi-Way," "Pioneer," and "Michigan" Chain Tapes.

THE LUFKIN RULE CO.
SAGINAW, MICHIGAN
PRECISION TOOLS—TAPES—RULES

EASY TO READ MARKINGS THAT ARE DURABLE

reality

(*Continued from page 26*)

"Look!" I said, and pointed to the dead Teleprinter.

He grunted and moved over to the squat unit and peered into the transparent check panel.

"Can't see any automatic systematic trouble lights on," he observed.

"It's just plain dead, Joe."

"Let's see," he paused, and looked at the chronometer tie-in at the left end of the machine. "This thing says it went out at 20:02.9. Why, that's just about half-way through your shift, Rudy. Didn't you come in and check it earlier?"

"You know, we don't check this thing like we do the banks," I defended.

"I'm hungry," he changed the subject abruptly.

"I'll fix the dispenser," I added quickly. Plainly, we both wanted to get out of there; something was wrong, and it was piling up in mountain-fulls around us all at once.

He went back to the wash room, and I went to the kitchenette and repaired the dispenser and reloaded it.

"Ahhh, fresh coffee." Joe was beaming as he came into the kitchenette. "Fill 'er up," he ordered. I drew out a mug-full for him and myself, and brought out a ready package of rations from the food dispenser. I set them down and we set to work opening and eating the palatable contents.

We sat and ate in silence, a forced and uncomfortable silence. Our usual attempts at humor or gruff, mock anger didn't appear. Even my coffee tasted strange and the food was like mushy pulp in my mouth. I threw down a bun and commented on the taste.

"It tastes funny to you too?" Joe looked up from his brooding, a strange look on his face.

"Yeah — like straw, no taste — and the coffee — ughhh."

"You hooked up the dispenser all right, didn't you? You sterilized and cleared out the pipes?"

"Of course."

"Oh, damn!" he moaned and threw down his half-munched bun, and swiveled in his chair and got up and started toward the door, muttering and swearing at the whole universe in general.

Joe screamed, and fell to the floor.

The room swam before my eyes. — "God, that food!" I thought.

"Joe! Joe, for Pete's sake, what's wrong?" I staggered over to him. He was on the floor, and his position — his position on the floor made something curdle all-fear within me. He was curled up, lying on his side, his head sunk deep into his chest and legs drawn up under him, and his arms folded slightly on his chest. He was still alive — I could see that. He was still breathing. I tried to uncurl him. He moaned and came back to consciousness.

He opened his eyes and looked around. "Did you see it, Rudy?" He looked at me with pleading eyes.

"See what?" I asked, knowing full well what he was referring to.

"The walls —" he paused. "The walls folded in, didn't they, Rudy? — Rudy, didn't they?"

"Yes, they did, Joe."

I turned and looked at the walls again — they were steady now.

"I think we had better call Base, Joe. This thing's getting too big."

"Yes," he answered in a whisper.

[*To be continued*]

THE DU PONT DIGEST

FOR STUDENTS OF SCIENCE AND ENGINEERING

EXCITING NEWS ABOUT

Du Pont's Newest Fiber

Hundreds of smaller businesses will join with Du Pont in bringing benefits of Orlon* acrylic fiber to you

Strong sunlight will damage most fibers—but not "Orlon" acrylic fiber, the latest synthetic yarn to come from the Du Pont laboratories. This remarkable fiber, which took eight years of intensive research to develop, has a lasting resistance to sunlight, mildew, high temperatures and even sulfuric acid. Experts say that it is the best fiber yet found for outdoor use.

In 1940, Du Pont scientists began work on a new fiber that seemed to have unusual properties. Development continued during the war when, under the name "Fiber A," the output went for military use in the hot, humid South Pacific. Recently the Du Pont Company decided to build a plant at Camden, South Carolina, for full-scale production. This new plant will cost about twenty-two million dollars.

While samples of "Orlon" fiber are now in the hands of knitters, weavers and finishers for experimental purposes, it will probably be late 1950 before articles made of it will be generally available. Then you can expect to see it in awnings, convertible automobile tops, golf bags, sails, electrical insulation, as well as certain articles of clothing.

In developing the uses of "Orlon," Du Pont will work with hundreds of smaller businesses—a "partnership" that will bring Americans not only new and better products, but more jobs, more business activity and another contribution to better living.

*TRADE-MARK

INDUSTRIAL *field will be largest initial consumer. Product's resistance to acids and high temperatures is important in items such as filter cloths, coveralls, ropes, and work clothes.*

OUTDOOR *uses of "Orlon" will include furniture fabric, golf bags, sweaters and swimming suits. New fiber stands up extremely well under sun and rain.*

SEND FOR the booklet "This is Du Pont." It is a 52-page picture story of one company's contributions to America. For your free copy, write to the Du Pont Company, 2503 Nemours Building, Wilmington, Delaware.

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BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

Great Dramatic Entertainment—Tune in "Cavalcade of America" Tuesday Nights, NBC Coast to Coast

briefing the news

Surgical Radio Receiver . . .

A tiny radio receiver which can be placed beneath a dog's skin surgically is now in use. Minute insulated wires run from the receiver, which is about the size of a ping-pong ball, to whatever nerve is being stimulated. The receiver picks up the radio impulses which are transmitted to the nerve.

The receiver is spherical and enclosed in a plastic substance which is not irritating. The wire running to the nerve is also enclosed in plastic, and is connected to the nerve by a small silver foil electrode, which fits sleeve-fashion around a section of the nerve.

Most nerve stimulation experiments in the past have necessitated electrical connections running through incisions in the dog's skin and into the nerve. The new apparatus transmits the stimuli by radio waves, making connections unnecessary. For experiments the dog is placed in a large cage, which is connected to a radio transmitter. When a nerve is to be stimulated, a signal is sent from the cage to the receiver.

The unique radio application makes it possible to study the reactions of nerves to stimuli with the animal in a normal physiological state. Other stimulation experiments have been performed with the dog under anesthetic, with the nerve laid bare, or with electrical leads running through his skin. In every case the dog has been in an abnormal state, which makes the scientific findings inaccurate.

A. C. Network Analyzer . . .

A machine has been developed which can duplicate in miniature hundreds of miles of transmission lines in vast electric power networks, and solve in minutes network problems ordinarily requiring weeks of calculation. Called the "A.C. Network Analyzer," the instrument includes miles of wire, hundreds of controls, sensitive measuring devices, and four plug-and-jack boards resembling those used by telephone operators.

A power network can be simulated on the analyzer by plugging lines into the plug-and-jack board to form small-scale versions of the real network. Small generators, representing power stations, send current through the simulated network, and the engineers can study the network's behavior at any point, under a variety of conditions.

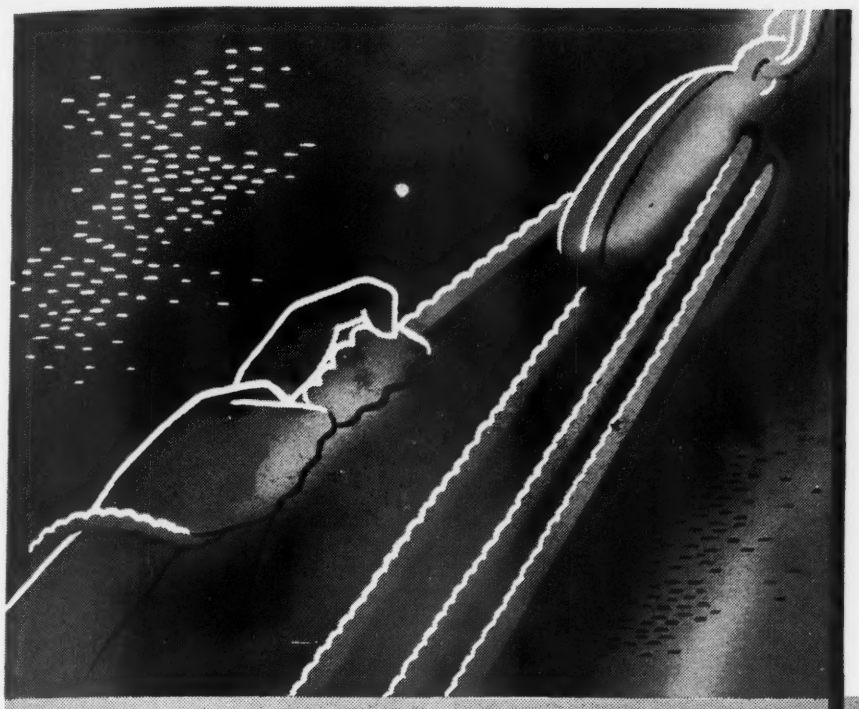
The analyzer enables engineers to determine what would happen in any part of a network if new lines were added, if a line were broken, or if a source of power were added. All these conditions can be duplicated on the new instrument. To find out what reactions such changes bring about in any circuit making up the network, the analyzer's chief operator pushes a numbered button on the control panel before him, and his instruments indicate the voltage, current, and power in the circuit that is of interest. The network analyzer can also be used to solve many other scientific problems capable of expression in electrical equivalents, such as the study of vibrations in machinery, or the flow of air over an airplane wing.

Electron Torch . . .

An "electronic torch" which can cut holes in fire brick has been recently developed. The tool combines high-frequency radio signals with certain gases to produce temperatures considerably higher than the melting point of Tungsten, which is 3,370 degrees C.

The heart of the torch is a tube known as a "magnetron," which produces radio waves with the extremely high frequency of one billion cycles per second. Leading from the tube is an antenna made of two short metal cylinders, one within the other. A high frequency arc is formed on the end of the antenna. The jet, which resembles a flame nine inches long, is produced when nitrogen or carbon dioxide is fed past the arc.

The high temperature produced on any surface placed in the jet is caused by the heat generated by atoms joining together to form molecules. The molecules of certain gases are broken up into atoms by the high frequency arc; when the atoms strike the surface, they reunite and give off considerable heat. The jet itself is not necessarily hot.



When sail trimming is required

No business can stay healthy without an occasional overhaul of its production set-up—particularly when a seller's market begins to quiver.

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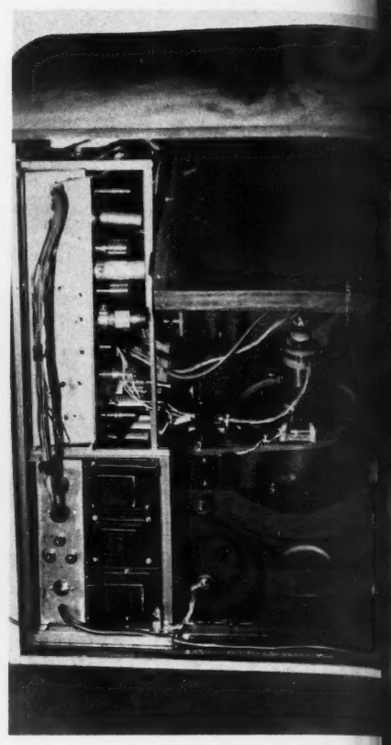


This photograph shows the "insides" of the CBS color television receiver with the rotating disk.

color tv fights it out

(*Continued from page 19*)

it is of the form of 2b, and the light is on at the peaks. In Figure 3e we see that the scan moves the sequence of little dots of light over one and a half dots after each scan. Thus finally the whole viewing screen will have had each primary color on every part of the screen. At any instant, however, the picture on the viewing screen consists of a sequence of little dots of different colors. Thus the RCA system depends on the retentive properties of the retina just as much as the CBS system.

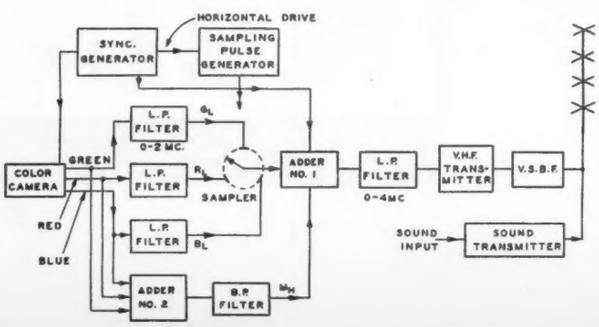
The RCA system exposes the viewing screen to the total light intensity of a part of the scene after it has gone through its sequence. Thus if the composite signal is applied to a kinescope without first sampling it, the result will be a black and white intensity picture. This explains how the color signals will produce a color program in monochrome on a black and white receiver.

Some interesting problems are present in these two color television systems. The CBS rotating disc method sometimes results in color breakup and color fringing. The RCA system has the problem of permanent color registration.

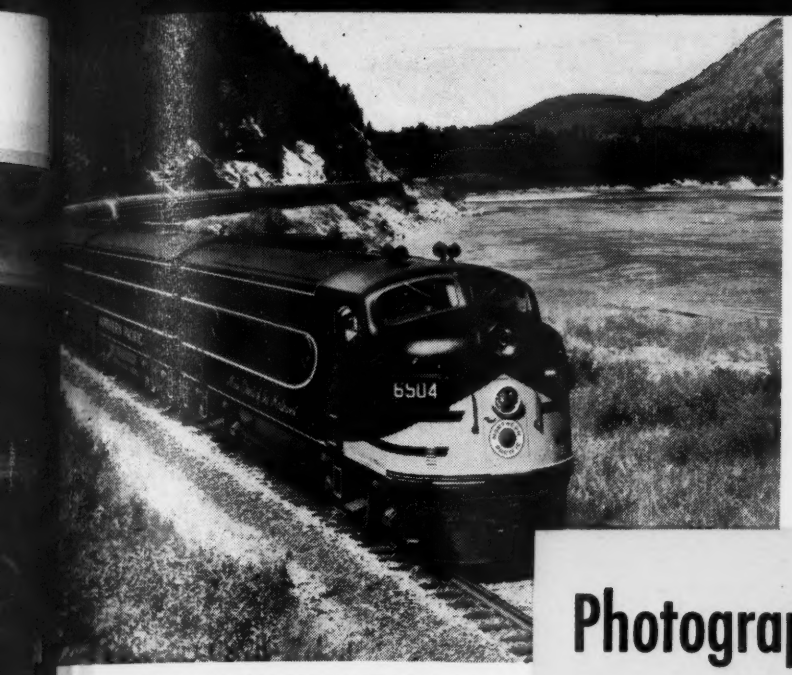
Color breakup is an occasional and momentary effect of separate color impressions in the eyes of some observers viewing disc-type color receivers. When the eyes of the observer move rapidly in relation to the viewing screen he sees the sequential color fields from different angles, and objects are in different positions for each different color field. Thus he would see a white stick as three sticks of different colors. This phenomenon is only produced by the rapid motion of the observer's eyes or by his rapidly moving his fingers across in front of his eyes. Therefore it is not a very great problem.

A similar phenomenon, color fringing, occurs when some object which is being televised moves rapidly in relation to the camera. The effect here is similar to a stroboscopic effect which sometimes occurs on monochrome. A rapidly falling white ball would be seen as a sequence of red, blue and green balls, just as a rapidly falling ball on monochrome might appear as a sequence of "stationary" white balls on the screen.

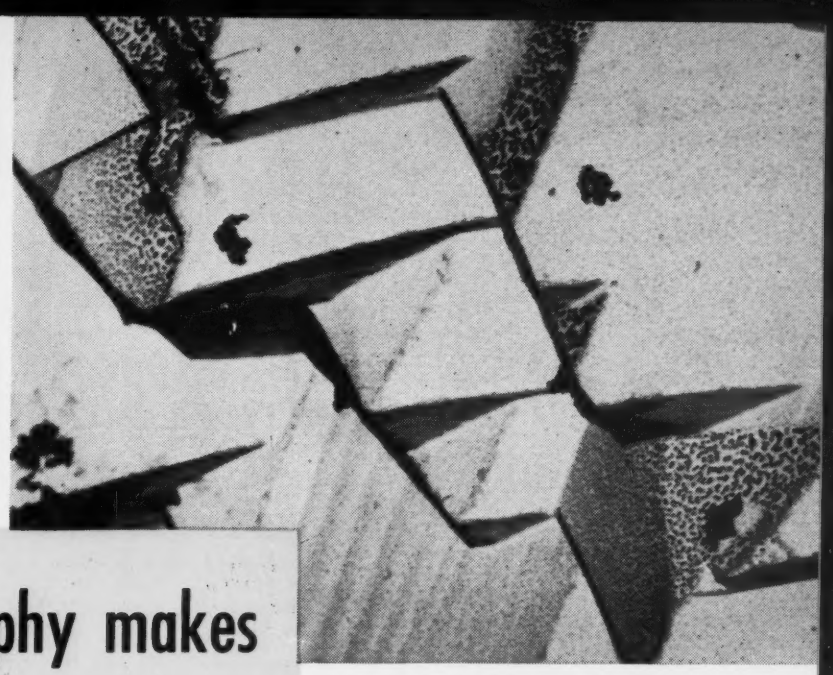
Color registration presents a problem in the RCA receiver. The three color pictures must be optically projected on the screen in exact registration. For instance, the whole red picture might be just a little to the right of the whole green picture. Thus an object which had green and red in it would have a red fringe on its right and a green fringe on its left. This condition can be brought about by jolting the optical system out of registration. The whole set-up in the RCA receiver must be built very sturdily to avoid color misregistration.



This block diagram shows the circuit on the transmitting end of the RCA system.



DISPLAYS MASSIVE PRODUCTS—A Diesel locomotive can roar across the Rockies—all on a movie screen in a prospect's office. All because photography can take huge things or small, and make them of a size for a salesman, teacher, or demonstrator to show.



MAKES MICROSCOPIC DETAILS CLEAR—Photography takes great magnifications produced by the electron microscope (20,000X) on fine-grain Kodak plates, enlarges and records them up to 100,000X on Kodak projection papers. Previously undetectable details and new facts are revealed.

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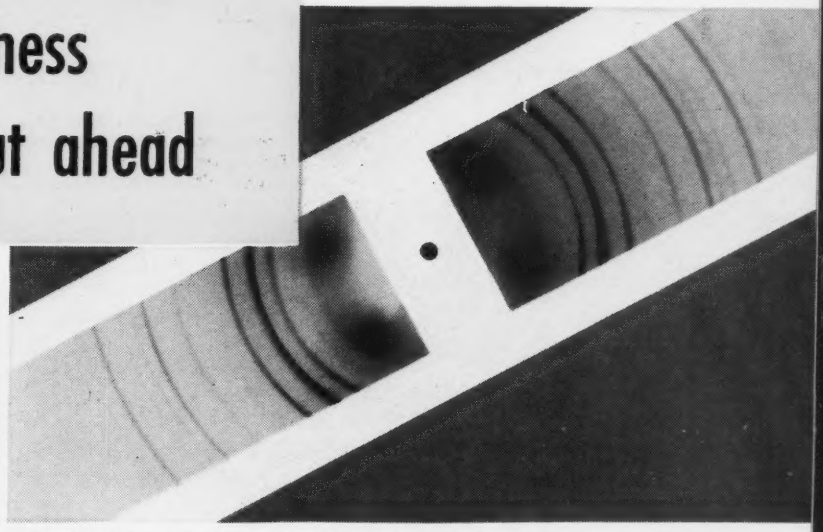

REVEALS STRUCTURE AND CONDITION OF METALS—X-ray diffraction patterns on Kodak films or plates provide important information concerning the crystal structure of metals. These patterns help show how alloys can be improved or new alloys made—give data on the effect of machining, drilling, and punching upon the structure of the material.

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It can magnify time with the high speed motion-picture camera so that the fastest motion can be slowed down for study. It can record the penetrating x-ray and reveal internal conditions of materials and products. With movies and stills, it can repeat a story, time and again, without the loss of a single detail.

Yes, photography serves business and industry in many important and valuable ways. It can work for you, too. If you would like to know how, please feel free to write for literature, or for specific information which could be helpful to you. Eastman Kodak Company, Rochester 4, New York.

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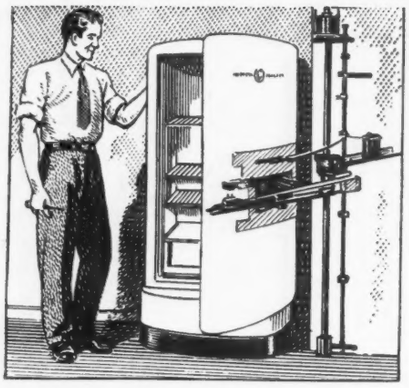
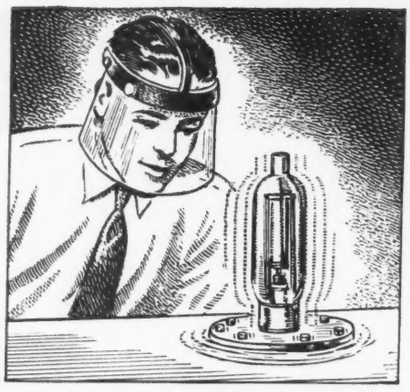
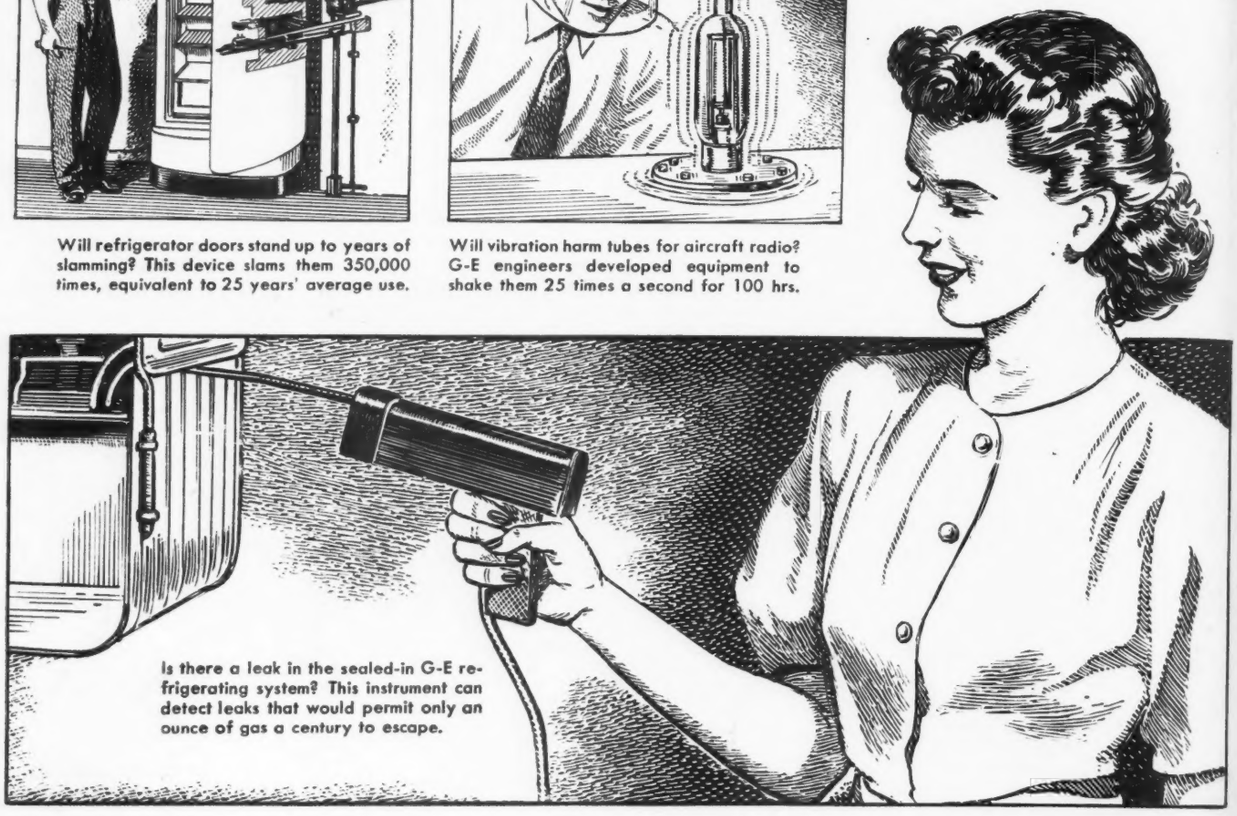


Will refrigerator doors stand up to years of slamming? This device slams them 350,000 times, equivalent to 25 years' average use.



Will vibration harm tubes for aircraft radio? G-E engineers developed equipment to shake them 25 times a second for 100 hrs.



Is there a leak in the sealed-in G-E refrigerating system? This instrument can detect leaks that would permit only an ounce of gas a century to escape.

These were also tough tests for G-E engineers . . .

A LEAK that would take years to deflate a tire is big enough to cause trouble in the cooling system of a refrigerator. How to devise test equipment sensitive enough to catch such microscopic flaws and eliminate them from General Electric units was also a tough test for engineering skill and ingenuity.

But the G-E engineer in search of solutions makes use of the stream of new ideas flowing from industry's largest technical staff—the more than 9000 scientists, engineers, chemists, physicists, and mathematicians employed by General Electric.

The principle for the new electronic leak-detector now being used to check refrigerators came out of the G-E Research Laboratory. Further development of it was carried on by the General Engineering and Consulting Laboratory. It was applied to refrigerator testing by engineers in the Company's Erie, Pennsylvania, plant.

To the consumer, this sort of teamwork means better, more dependable, longer-lasting General Electric products. To the engineer it means more varied opportunities, quicker development, the advantages of belonging to an organization where emphasis on research and incentives for creative thinking are the tradition.

You can put your confidence in—

GENERAL ELECTRIC